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# Gunnison County Stream Water Quality Study

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# GUNNISON COUNTY STREAM WATER QUALITY STUDY

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This research was done to determine the water quality of all major streams in Gunnison County during Calendar Year 1977. A large number of biological, chemical and physical water quality parameters were assessed. Also included in the study was a review of existing literature and other pertinent water quality data, integrating that information with the conclusions from the 1977 research.

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# GUNNISON COUNTY

# STREAM WATER QUALITY STUDY

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This study was conducted
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and Gunnison County, Colorado
Gunnison, Colorado 81230

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# FOREWORD

The generally high quality of the water in the streams of Gunnison County, Colorado contributes to the health, prosperity and happiness of many thousands of individuals, both residents and visitors. Countless other thousands downstream depend upon Gunnison water. Maintenance of high quality will be difficult in the face of increasing pressure from urbanization, mining, tourism and other forces. Such maintenance is based upon knowing exactly what is the current water quality - the subject of this research.

The Colorado State University Mountain Meadow Research Center is involved in improving management of irrigation water. The Center has been privileged to render public service in cooperating with Gunnison County and the U.S. Environmental Protection Agency in conducting the base line studies of water quality described in this report.

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Superintendent and Professor
Colorado State University
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## ABSTRACT

This research is intended to establish base line water quality for the major streams in Gunnison County.

The study involved thirty-two stations sampled seasonally, monthly, or semi-monthly and evaluation of water quality parameters including: DO, $BOD_5$, total coliform, fecal coliform, fecal streptococcus, Ca, Na, K, Mg, B, $SO_4^{-2}$, $F^-$, $Cl^-$, $NH_3$-N, $NO_3^-$-N, $PO_4^{-3}$-P, TKN, Al, As, Cd, Cr, Cu, Fe, Mn, Pb, Zn, temperature, velocity, pH, suspended solids and conductivity.

Data available to the County through STORET and several other studies were retrieved and catalogued to provide background and supplemental information.

Insofar as analyses permitted classification, and with seven exceptions, sampled stream segments met the criteria of the 1974 Colorado State Classification $A_1$, or the 1978 classes Cold Water Biota Class 1, Domestic Water Supply Class 2, Recreational Class 1, and Agricultural. Principal exceptions were to:

a. biological parameters, pH values and dissolved ammonia during warm weather, and,

b. metal parameters in the Keystone Mine area of Slate River and Coal Creek.

This report is submitted in fulfillment of EPA Project WA75-R577 and Grant 68-01-3589 by Colorado State University Mountain Meadow Research Center in cooperation with Gunnison County. This report covers the period January 1, 1977 to December 31, 1977 and work was completed as of August, 1978.

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## LIST OF ABBREVIATIONS AND SYMBOLS

### ABBREVIATIONS

| | |
|---|---|
| BOD | - biochemical oxygen demand |
| C.G. | - campground |
| COD | - chemical oxygen demand |
| col/100 ml | - colonies per 100 milliliters |
| DO | - dissolved oxygen |
| FS | - fecal streptococcus |
| FTU | - formazin turbidity units |
| MBAS | - methylene blue active substances |
| mg/l | - milligrams per liter |
| ug/l | - micrograms per liter |
| umho | - ohms |
| ppm | - parts per million |
| STORET | - (data) storage retrieval (system) |
| SU | - standard units |
| TNTC | - too numerous to count |

### State of Colorado Water Classifications

| | |
|---|---|
| $A_1$ | - primary contact recreation 1974 classification |
| $B_1$ | - secondary contact recreation 1974 classification |
| CWB-C1 | - Cold Water Biota, Class 1 July, 1978 classification |
| DWS-C2 | - Domestic Water Supply, Class 2 July, 1978 classification |
| REC-C1 | - Recreational, Class 1 July , 1978 classification |
| AGR | - Agricultural July, 1978 classification |

### SYMBOLS

| | |
|---|---|
| Ag | - silver |
| Al | - aluminum |
| As | - arsenic |
| B | - boron |
| Ca | - calcium |
| Cd | - cadmium |
| $Cl^-$ | - chloride |
| Cr | - chromium |
| $CO_2$ | - carbon dioxide |
| $CO_3^{-2}$ | - carbonate |
| CN | - cyanide |
| Cu | - copper |
| $F^-$ | - fluoride |
| Fe | - iron |
| Hg | - mercury |
| $HCO_3^-$ | - bicarbonate |
| K | - potassium |
| Mg | - magnesium |
| Mn | - manganese |
| Na | - sodium |
| $NH_3$-N | - ammonia nitrogen |
| $NH_4^+$ | - total ammonia ($NH_4^+$+$NH_3$) |
| $NO_2$-N | - nitrite nitrogen |
| $NO_3$ | - nitrate |
| $NO_3$-N | - nitrate nitrogen |
| Pb | - lead |
| $PO_4^{-3}$-P | - phosphate phosphorus |
| $SO_4^{-2}$ | - sulfate |
| TKN | - total Kjeldahl nitrogen |
| Zn | - zinc |

# INTRODUCTION

Traditionally the 3,200 square mile area of Gunnison County, located within the mountains of west-central Colorado, has been largely agriculture-oriented, with forests, rangeland and irrigated meadows covering most of the land. Coal and precious metal mines were numerous during only the first twenty years of settlement and the few communities that did exist had small populations. The one million acre feet of water produced per year in the Upper Gunnison River sub-basin and other streams in the County were reputed to be fairly pure except during the time when late spring run-off of snowmelt occurred.

Forces are now coming into play which will significantly alter the nature of the County and its water supply. Major deposits of molybdenum and uranium are now under development, and large coal reserves are likely to be developed in the near future. Increased recreational activity and incipient mining are already significantly increasing the area's population. These forces will tend to degrade water supplies unless extreme care is exercised.

Gunnison County planners foresaw a strong need to determine the base line levels of water quality in advance of more development. Earlier studies, though fairly numerous, tended to be scattered and fragmentary and to deal primarily with point-source pollution.

The County procured federal assistance and contracted with Colorado State University to conduct research to meet the need for data - the research considered in this report.

The specific purposes of this research were:

1. To repeatedly determine the water quality of all major Gunnison County streams during one calendar year, 1977. Quality was assessed in terms of a large number of biological, chemical and physical parameters.

2. To determine which streams fell short of acceptable standards for water quality.

3. To review existent literature and other pertinent water quality data, and to integrate the information with conclusions from this 1977 research.

# CONCLUSIONS AND RECOMMENDATIONS

## CONCLUSIONS

Base line research studies conducted at thirty-two sites upon the streams of Gunnison County during 1977 indicate the general high quality of the water. Forty-one percent of the sites met the 1974 $A_1$ standards. Thirty-four percent of the sites showed excessive fecal streptoccus during May and June, prohibiting the $A_1$ classification. Twenty-five percent of the sites were classified $B_1$. According to the proposed 1978 standards, fifty-nine percent of the sites met the Cold Water Biota Class 1 criteria; twenty-five percent of the sites missed this classification by slightly excessive concentrations for one parameter of water quality - aluminum, ammonia or zinc. Nine percent of the sites had two parameters in excess. Seventy-five percent of the sites met the criteria for classification as Domestic Water Supply, Class 2; sixteen percent of the sites missed this classification because of one parameter in excess (manganese), while one site (3%) had two parameters in excess (manganese and fluoride). Two sites (6%) met only the less restrictive criteria for recreational and agricultural use. Numerous sites showed high values for biological parameters, pH and dissolved ammonia during May and June, primarily.

Miscellaneous, previously-conducted water quality studies generally confirmed the high quality of county streams, but low levels of dissolved oxygen were noted on occasion, as well as excessive amounts of lead, zinc, mercury, sulphate, iron, manganese and ammonia at some sites, at some times. These studies frequently concerned point-source pollution. Significant deviation from high water quality occurred only in the area of the Keystone Mine drainage on the Slate River and Coal Creek; mine effluent has been reduced since collection of these data.

## RECOMMENDATIONS

There should be some program for continuous spot-checking of Gunnison county streams in order to detect the onset of possible degradation.

Potential point-source and non-point-source pollution should be identified; corrective measures should be taken, where fiscally possible.

The summer rise in the level of biological pollutants should be studied in depth in order to determine probable sources, the significance of it, and whether stream improvement can or should be achieved. Specifically, we should study the possible pollution of streams by run-off from grazed lands; management procedures might possibly be developed to lessen pollution.

Additional work to evaluate base line levels of molybdenum and radioactive substances should be conducted, to supplement that already available.

## STUDY AREA AND SAMPLING SITES

### WATERCOURSES STUDIED AND LAND USE

Waters of all rivers and major creeks in Gunnison County were sampled to determine their water quality in this study. These watercourses are grouped by drainage in the following information; in addition, stream origin and direction of flow are indicated. The primary land use for major drainages is also given in the following:

Tomichi Creek Drainage:

| | | | |
|---|---|---|---|
| Tomichi Creek | Sawatch Mountains | S, NW | ( Hay production, |
| Hot Springs Creek | Waunita Hot Springs | WSW | ( Grazing, |
| Quartz Creek | Sawatch Mountains | SW | ( Timber production, |
| Gold Creek | Fossil Ridge | S | ( and |
| Cochetopa Creek | Cochetopa Hills | E, N | ( Recreation |

Taylor River Drainage:

| | | | |
|---|---|---|---|
| Willow Creek | Sawatch Mountains | NNW | ( Timber production, |
| Texas Creek | Elk Mountains | W | ( Grazing, and |
| Taylor River | Elk Mountains | SE, S | ( Recreation |

East River Drainage:

| | | | |
|---|---|---|---|
| Cement Creek | Italian Mountains | SSW | ( Recreation, |
| Slate River | Elk Mountains | SE | ( Grazing, |
| Oh-Be-Joyful Creek | Ruby Range | ESE | ( Mining, |
| Coal Creek | Ruby Range | E | ( and |
| East River | Elk Mountains | SSE | ( Hay production |

North Fork Drainage:

| | | | |
|---|---|---|---|
| Anthracite Creek | Anthracite Range | WSW | ( Coal Mining, |
| Coal Creek | West Elk Mountains | N | ( Grazing, |
| Muddy Creek | Grand Mesa | SSE | ( Timber, and |
| North Fork Gunnison River | confluence of Anthracite & Muddy | W | ( Hay and Fruit ( production |

Gunnison River Drainage:

| | | | |
|---|---|---|---|
| Ohio Creek | Anthracite Range | SSE | ( Grazing, |
| Gunnison River | confluence of East & Taylor Rivers | SW, W | ( Hay production, ( Recreation, |
| Cebolla Creek | San Juan Range | NNW | ( and |
| Lake Fork Gunnison River | San Juan Range | N | ( Timber |
| Little Blue Creek | Alpine Plateau | N | |
| Big Blue Creek | San Juan Range | N | |
| Crystal River: | Elk Mountains | NW | ( Recreation and ( Timber |

## LOCATIONS OF SAMPLING SITES AND FREQUENCY OF SAMPLING

Thirty-two sampling sites were established throughout the County. The sites were chosen to be as representative as possible of the entire stream segment being sampled. Because the object of this study is to establish the general water quality for those segments, the few known point-sources of pollution were not evaluated.

The approximate location of each sampling site on each watercourse is shown in Figure 1, pg 8 . The STORET location code, excluding the County designation (08), is used as the symbol for the site location on the map and throughout this study; for example, the symbol for site 08TC03 is TC03.

Sampling occurred seasonally (spring, summer, fall), monthly, or semi-monthly, depending on location. During the summer sampling period (August, 1977) sediment samples were taken at all sites, in addition to the regular water samples. Sampling began on January 3, 1977 and ended December 29, 1977.

The approximate locations of sites included in other water studies conducted in this county are shown on Figure 2, pg 9 . Reference numbers assigned to the sites to facilitate discussion in the Results section and for use in Table 2 of that section are arbitrarily chosen to avoid the confusion of the several numbering systems in the original studies.

The immediately following information includes site name, site symbol, coordinate location, site description, and frequency of sampling for each site in the present study.

Tomichi Creek Drainage

| | | | |
|---|---|---|---|
| Tomichi Creek 3 (TC03) | 106° 25' 17.7"<br>38° 24' 3.5" | @ Hwy.#50 bridge, .5 mile W. of Sargents | Monthly |
| Hot Springs Creek (HSCK01) | 106° 31' 51.1"<br>38° 30' 55.3" | Above Hot Springs Res.at Res. inlet, 1.2 miles W. of Waunita Hot Springs Resort | Seasonal |
| Tomichi Creek 2 (TC02) | 106° 43' 43.2"<br>38° 30' 15.6" | .5 mile E. of confluence of Tomichi Creek and Quartz Creek @ Parlin | Seasonal |
| Quartz Creek 2 (QC02) | 106° 30' 39.7"<br>38° 36' 53.8" | Pitkin C.G. bridge, .2 mile above Pitkin | Seasonal |
| Quartz Creek 1 (QC01) | 106° 32' 30.0"<br>38° 34' 45.3" | Directly opposite entrance to Roosevelt C.G., 2 miles W. of Pitkin | Seasonal |
| Gold Creek 2 (GC02) | 106° 34' 10.3"<br>38° 39' 26.2" | 6 miles N. of Ohio City at Gold Creek C.G. | Seasonal |
| Gold Creek 1 (GC01) | 106° 36' 19.6"<br>38° 34' 53.1" | 1 mile N. of Ohio City on Gold Creek Road | Seasonal |

| | | | |
|---|---|---|---|
| Cochetopa Creek (CHACK01) | 106° 25' 58.5"<br>38° 22' 57.0" | .4 mile N. of Gunnison/ Saguache county line, 35 ft. W. of Hwy.#114 road bed | Seasonal |
| Tomichi Creek (TC01) | 106° 56' 22.6"<br>38° 31' 46.8" | 2 miles S. of Gunnison on Gold Basin Road @ USGS Gauge Station | Two weeks |
| <u>Taylor River Drainage</u> | | | |
| Willow Creek 1 (WC01) | 106° 33' 36.4"<br>38° 49' 4.7" | First bridge above Taylor Park Res., crossing Willow Creek | Seasonal |
| Texas Creek (TEXC01) | 106° 33' 14.7"<br>38° 50' 55.3" | Bridge crossing Texas Creek .5 mile N.E. of Taylor Park Res. | Seasonal |
| Taylor River 2 (TR02) | 106° 35' 11.8"<br>38° 54' 19.5" | Dinner Station C.G. well site 4 miles N. of Taylor Park Res. | Seasonal |
| Taylor River 1 (TR01) | 106° 50' 41.3"<br>38° 39' 51.5" | Taylor Road Bridge crossing Taylor River at USGS Gauge Station | Two weeks |
| <u>East River Drainage</u> | | | |
| Slate River 2 (SR02) | 107° 00' 27.5"<br>38° 54' 29.0" | Above confluence with Oh-Be-Joyful Creek above Crested Butte | Seasonal |
| Oh-Be-Joyful Creek 1 (OBJ01) | 107° 00' 27.5"<br>38° 54' 28.0" | Above confluence with Slate River, take first road past bridge from Crested Butte crossing Slate River to Gunsite Pass 4-WD road, cross old bridge to old mine site | Seasonal |
| Coal Creek 1 (COACK01) | 107° 02' 0.0"<br>38° 51' 55.3" | 1.2 miles above Keystone Mine entrance, located 2 miles above Crested Butte | Monthly |
| Slate River 3 (SR03) | 106° 58' 18.0"<br>38° 51' 20.0" | 1 mile below Crested Butte at Hwy.#135 bridge | Monthly |
| Slate River 1 (SR01) | 106° 54' 12.1"<br>38° 48' 52.4" | @ Hwy.#135 bridge 5 miles below Crested Butte | Monthly |
| Cement Creek 1 (CEMCK01) | 106° 51' 57.1"<br>38° 49' 15.6" | USFS Guard 1 mile N. of Hwy.#135 | Seasonal |

| | | | |
|---|---|---|---|
| East River (ERO1) | 106° 50' 50.2"<br>38° 39' 50.3" | @ Almont Hwy.#135 bridge 50 ft. upstream of confluence with Taylor River | Two weeks |
| North Fork Drainage | | | |
| Anthracite Creek (ACO1) | 107° 20' 37.4"<br>38° 55' 24.6" | 5 ft. above confluence with Coal Creek (North Fork Drainage) 1 mile above confluence with Muddy Creek | Seasonal |
| Coal Creek (CCNFO1) | 107° 20' 37.4"<br>38° 55' 24.6" | Above confluence with Anthracite Creek @ bridge 1 mile above confluence with Muddy Creek | Seasonal |
| Muddy Creek (MCO1) | 107° 20' 49.2"<br>38° 59' 15.6" | @ bridge crossing Muddy Creek (Hwy.#133) above Paonia Res. 40 ft. S. of bridge on E. side of creek bed | Seasonal |
| North Fork (NFGO1) Gunnison River | 107° 13' 35.4"<br>38° 19' 24.9" | .6 mile E. of Gunnison/ Delta county line, 30 ft. E. of Bear Creek/North Fork Gunnison confluence | Two weeks |
| Gunnison River Drainage | | | |
| Ohio Creek 1 (OHO1) | 106° 55' 51.2"<br>38° 35' 17.2" | 2.8 miles N. of Gunnison @ Castle Mountain Estates, 1 mile W. of main entrance @ bridge | Seasonal |
| Gunnison River 1 (GRO1) | 106° 59' 39.8"<br>38° 31' 4.6" | @ McCabe Lane Bridge, 3.2 miles S.W. of Gunnison | Two weeks |
| Cebolla Creek 2 (CEBO2) | 107° 33' 14.8"<br>38° 11' 15.7" | @ C.G. 7.5 miles S. of station CEBO1 | Seasonal |
| Cebolla Creek 1 (CEBO1) | 107° 06' 48.2"<br>38° 19' 24.9" | @ Hwy.#149 bridge crossing Cebolla Creek near Powderhorn | Monthly |
| Lake Fork (LFGO1) Gunnison River | 107° 13' 35.4"<br>38° 19' 24.9" | 100 yds. S. of Lower Lake Fork Bridge at Red Bridge C.G. | Two weeks |
| Little Blue Creek (LBO1) | 107° 24' 25.6"<br>38° 24' 25.6" | @ Halfway House on Hwy.#50 5 miles W. of Blue Mesa Dam above confluence with Big Blue Creek | Seasonal |

| | | | |
|---|---|---|---|
| Big Blue Creek (BB01) | 107° 24' 25.6"<br>38° 24' 15.6" | @ Halfway House on Hwy.#50<br>5 miles W. of Blue Mesa Dam, 10 ft. above confluence with Little Blue Creek | Seasonal |
| Crystal River (CRY01) | 107° 14' 27.5"<br>39° 05' 7.8" | 3 miles W. of Marble @ Hwy.#133 bridge | Seasonal |

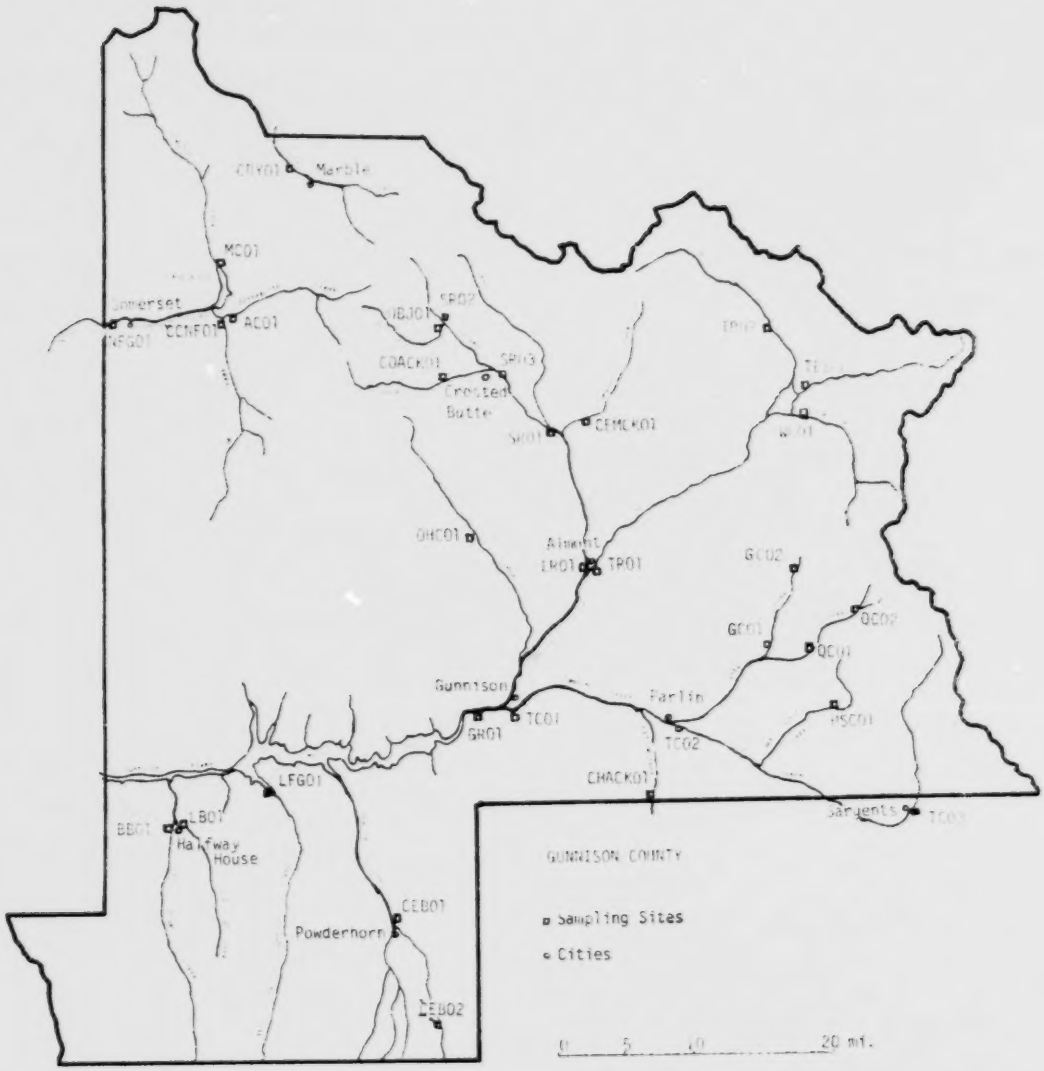


Figure 1. Station Locations, Base Line Study

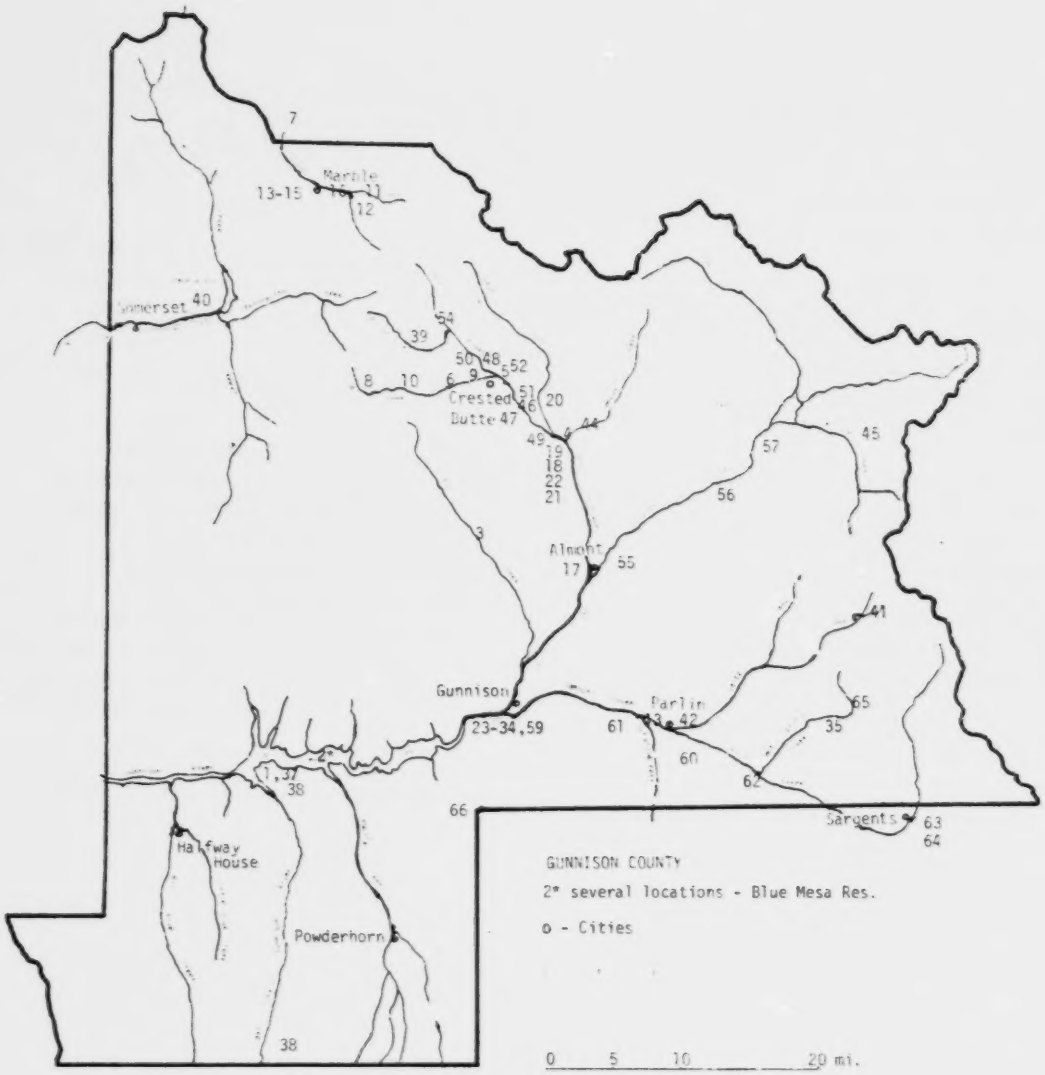


Figure 2. Sites Reported in STORET

## EXPERIMENTAL PROCEDURES

The sites designated in the previous section were sampled at the indicated times in accordance with accepted EPA Methods outlined in "Methods for Chemical Analysis of Water and Wastes" and "Standard Methods for Examination of Water and Wastewater", 14th Ed. Water temperature, pH and velocity measurements were taken in situ.

The samples collected were then analysed for the parameters listed in Parameters Studied and Analytical Procedures. Data gathered in the sample analysis was averaged and standard deviations run where possible. The range average and standard deviations are presented in Appendix Tables A-1 to A-7. Appendix Figures A-1 through A-28 show the same data on maps so that variations from site to site on a given water course can be examined.

The data were then used to determine which State of Colorado Water Classification could be best applied to each site by the methods described in Classification Procedures. A similar analysis of data available from previous studies was done and those sites (Figure 2, pg 9 ) fitted into the classification scheme (Table 3, pg19 ). Because of the extensive nature of this data, tables analogous to Appendix Tables A-1 through A-7 are not presented Instead, it was arranged by parameter on a county-wide basis. The number of measurements, average value and range for each parameter are given in Appendix Table A-11, where they are listed by STORET number, indicating the analytical procedure used in the analysis. These data are all available in the Gunnison County Sanitarian's office by site and by parameter.

Discussion of the results in terms of site and parameter is included in Results section.

PARAMETERS STUDIED AND ANALYTICAL PROCEDURES

All parameters considered under the 1974 system of classifying water quality were studied in this research. In the case of biologicals, samples were taken repeatedly over a long period of time, instead of intensively over a short period of time (the recommended procedure).

Analyses for metals extractable from sediments were run for only one sampling date. Other analyses for metals (including some listed subsequently under minerals) were conducted only on "seasonally-collected-samples".

Cyanide was determined in samples, but data are not reported since no measurable quantity was found (less than 10 micrograms per liter).

The following information lists parameters studied and references for analytical procedures used in the study; analyses were conducted at the Colorado State University Mountain Meadow Research Center, unless noted otherwise:

Biological Parameters:

Total Coliform - Membrane Filter 909A: pp 928-935, Standard Methods for Examination of Water and Wastewater, 14th Ed. APHA-AWWA-WPCF.

Fecal Coliform - Membrane Filter 909C: pp 937-939. ibid.

Fecal Streptococcus - Membrane Filter 910B: pp 944-945. ibid.

Dissolved Oxygen (DO) - Azide Modification 422B: pp 433-447. ibid.

Biochemical Oxygen Demand (BOD) - Azide Modification 507: pp 543-550. ibid.

Nutrient Parameters:

Ammonia Nitrogen ($NH_3$-N) - Nesslerization 418B: pp 412-416, Chemical Procedures, Standard Methods for Examination of Water and Wastewater, 14th Ed. APHA-AWWA-WPCF.

Nitrate Nitrogen ($NO_3^-$-N) - Chromotropic Acid 419E: pp 429-431. ibid.

Phosphate Phosphorus ($PO_4^{-3}$-P) - Ascorbic Acid 425F: pp 481-483. ibid.

Total Kjeldahl Nitrogen (TKN) - Nitrogen, Kjeldahl, Total STORET No. 00652 Micro Kjeldahl System 7.3: pp 178-181, Methods for Chemical Analysis of Water and Wastes. EPA 625/6-74-003.

Mineral Parameters:

Sulfate ($SO_4^{-2}$) - Turbidimetric Method 427C: pp 496-498, Chemical Procedures, Standard Methods for Examination of Water and Wastewater, 14th Ed. APHA-AWWA-WPCF.

Chloride ($Cl^-$) - Argentometric Method 408A: pp 303-304. ibid.

Fluoride ($F^-$) - Electrode Method 414B: pp 391-393. ibid.

Cyanide ($CN^-$) - Colorimetric Method 413D: pp 370-372. ibid.

Boron (B) - Analyzed with an Inductively Coupled Electron Emission Plasma Spectophotometer by the Colorado State University Soil Testing Laboratory.

Calcium (Ca) - " " " " "

Magnesium (Mg) - " " " " "

Potassium (K) - " " " " "

Sodium (Na) - " " " " "

Metal Parameters:

NOTE: For sediment analyses, metals extracts were prepared by the procedure Metals 4.1.3 pp 82-83, Methods for Chemical Analysis of Water and Wastes. EPA 625/6-74-003. Extracts were then analysed as water samples by the laboratories listed. All analyses are for total metal content.

Arsenic (As) - Atomic Adsorption by the Colorado State University Analytical Chemistry Facility.

Aluminum (Al) - Analyzed with an Inductively Coupled Electron Emission Plasma Spectophotometer by the Colorado State University Soil Testing Laboratory.

Cadmium (Cd) - " " " " "

Chromium (Cr) - " " " " "

Copper (Cu) - " " " " "

Iron (Fe) - " " " " "

Manganese (Mn) - " " " " "

Lead (Pb) - " " " " "

Zinc (Zn) - " " " " "

Physical Parameters:

Temperature - Section 212: pp 125-126, Standard Methods for Examination of Water and Wastewater, 14th Ed. APHA-AWWA-WPCF.

Conductivity - Section 205: pp 71-74. ibid.

pH - Section 424: pp 460-465. ibid.

Total Non-filterable Residue (Suspended Solids) - Dried at 103-105C - Section 208D: pp 94. ibid.

Velocity - Pitot tube - U.S. Department of Interior Bureau of Reclamation Water Measurement Manual, 2nd Ed. Cat. No. I 27.19/2: W29/2/974. Chap. 7, pp 159-161.

## PARAMETERS NOT STUDIED

The State of Colorado uses some parameters not considered in this study in their classification of surface waters. These include: algae, barium, beryllium, chlorine, mercury, molybdenum, nickel, pesticides, selenium, silver, thallium, turbidity, uranium, and other radioactive materials. These parameters were not considered to be of significance for this study because of an absence of sources for introduction into stream water.

## DATA FROM OTHER SOURCES

Water quality data from other sources are included in this report, as requested by EPA and Gunnison County. Data was supplied from the STORET system and water studies by James Erickson of Four Corners Environmental Research Institute, and John Woodling of the Colorado Department of Public Health. Data were catalogued by site and by parameter. The STORET data was contributed primarily by the United States Geological Survey and the Colorado Department of Public Health. There are sixty-two sites represented, and forty-two parameters measured, including fourteen metal, ten mineral, three biological, four physical, and eleven nutrient parameters, for a total of 8,076 individual measurements.

## CLASSIFICATION PROCEDURE

The classification of a stream segment involved the comparison of the available average parameter measurements for the site representing the segment, with the criteria applied to that parameter by the Water Quality Control Commission, Colorado Department of Health. All data from this study and all other studies reviewed were evaluated.

The criteria for classes $A_1$ and $B_1$ were taken from "Water Quality Standards and Stream Classification"; pp 3-6; Adopted: January 15, 1974; Effective: June 19, 1974.,

and for REC-C1, CWB-C1, AGR and DWS-C2 from "Water Quality Standards for Colorado"; Adopted: May 2, 1978; Effective: July 20, 1978.

The specific criteria for parameters measured in this study are shown in Table 1, pg 15.

The stream segment was placed in a given classification if the mean values of the measured parameters met the criteria for that class with at most two exceptions, and any exceptions noted. Some sites showed out-of-limits values for unionized ammonia ($NH_3$), pH and fecal streptococcus (FS). This is an apparently seasonal phenomenon correlated with run-off from irrigated, grazed meadows during warm weather. Unless this "biological pollution" occurred year-round, the values were not considered to be descriptive of the overall character of the stream, and they were omitted in determining stream classification (not permitting a few high values to negate the weight of many low ones). In this connection it should be repeated that accepted procedures call for five determinations over a 30 day period; it was the opinion of those conducting this study, or counselling for it, that repeated determinations over one year was more descriptive, and so the latter procedure was used.

Sites in the present study that met the criteria for CWB-C1 or DWS-C2 also met those for REC-C1 and AGR.

Some of the parameters studied do not have specific numerical criteria with respect to any class at the present time. Those in this study are: conductivity, suspended solids, stream velocity, phosphate-phosphorus, total Kjeldahl nitrogen, sodium, potassium and calcium. In addition, turbidity measurement, MBAS, algae, alkalinity measurements and hardness measurements, several types of residue measurements are included in other studies but are not used in classification schemes.

Table 1. STATE OF COLORADO WATER QUALITY STANDARDS

| Parameter | Class. $A_1$ | Class. $B_1$ | Class. CWB-C1 | Class. DWS-C2 | Class. REC-C1 | Class. AGR |
|---|---|---|---|---|---|---|
| DO (mg/l) | >6 | >6 | >6 | aerobic | aerobic | aerobic |
| pH (su) | 6.5-8.5 | 6.0-9.0 | 6.5-9.0 | 5.0-9.0 | 6.5-9.0 | - |
| Temp (°C) | < 20 | < 20 | < 20 | < 20 | - | - |
| Al (µg/l) | - | - | 100 | - | - | - |
| As (µg/l) | - | - | 50 | 50 | - | 100 |
| Cd (µg/l) | - | - | .4 | 10 | - | 10 |
| Cr (µg/l) | - | - | 100 | 50 | - | 100 |
| Cu (µg/l) | - | - | 10 | 1000 | - | 200 |
| Fe (µg/l) | - | - | 1000 | 300 | - | - |
| Mn (µg/l) | - | - | 1000 | 50 | - | 200 |
| Pb (µg/l) | - | - | 4 | 50 | - | 100 |
| Zn (µg/l) | - | - | 50 | 5000 | - | 2000 |
| $NH_3$ (mg/l) | - | - | .02 (un-ionized) | .5 (total) | - | - |
| $Cl^-$ (mg/l) | - | - | - | 250 | - | - |
| $Fl^-$ (mg/l) | - | - | - | 2.4-1.4 | - | - |
| $NO_3^-$ (mg/l) | - | - | - | 10 | 100 | - |
| Mg (mg/l) | - | - | - | 125 | - | - |
| $SO_4^{-2}$ (mg/l) | - | - | - | 250 | - | - |
| $PO_4^{-3}$ (mg/l) | determined by site | | | | | |
| Fecal Coliform (col/100ml) geometric mean | 200 | 1000 | - | 1000 | 200 | 1000 |
| Fecal Strep (col/100ml) geometric mean | 20 | - | - | - | - | - |
| Total Coliform (col/100ml) geometric mean | 1000 | 10,000 | - | - | - | - |

# RESULTS

Gunnison County waters are generally high in quality, as subsequent data will show in this section of the report. The first part of this section emphasizes the overall classification of water at individual sites. The second part of this section emphasizes individual parameters of water quality - showing how the parameter varies with sites.

## CLASSIFICATION OF WATER QUALITY AT SAMPLING SITES

Note: Tables 2 and 3 (pg 17 and 19) list each sampling site and its ascribed water classification. The "best-fit" assessments of classification were made on the basis of data made available through our "base line study" research measurements or on the basis of data from other research studies. In many instances, data were not available for all parameters used in classification; thus, classification assessments are incomplete. In the base line study, we studied all parameters which might realistically be considered possible problems for our county. See "Classification Procedures", page 14 for further notes on this subject.

Thirteen out of the 32 base line sites (or 41%) can essentially be placed in the 1974 $A_1$ category (Table 2 ). Eleven out of 32 (34%) are essentially $A_1$, except for excessive counts of fecal streptococcus at one time or another. The remaining 8 sites are classified $B_1$ (25% of the total). By the 1978 classification scheme, 19 of the 32 sites (59%) meet the Cold Water Biota Class 1 (CWB-C1) criteria. Eight sites meet CWB-C1 specifications except for one parameter (25%). Three sites miss CWB-C1 by two parameters (9%). Twenty-four sites meet the criteria for DWS-C2 (75%). Five sites missed this classification by one parameter (16%). One site missed DWS-C2 by two parameters (3%). All sites met the criteria for Recreation Class 1 (REC-C1) and Agricultural (AGR), but one site (3%), Coal Creek, only met these class criteria. Muddy Creek met the class criteria for REC-C2 and AGR.

Classified solely upon the limited data available, 60 of the 64 STORET sites may be classified $A_1$ (94% of the total); the remainder are classified $B_1$ (6%) (Table 3 ). Under the 1978 classification system, 40 of the 64 (62%) are classified CWB-C1 and DWS-C2. At the middle bridge over Blue Mesa Reservoir (location #2), low levels of dissolved oxygen prohibited the CWB-C1 classification. At the juncture of Coal Creek and Elk Creek (location #9), on Oh-Be-Joyful Creek (location #39) and on the Slate River above Crested Butte (location #48), excessive lead and zinc exceeded DWS-C2 limits. Coal Creek at Irwin (location #7) had excessive lead, alone. The South Fork of the Crystal River (location #12), one location on the Gunnison River (location #34), Middle Quartz Creek (location #40), Sanford Creek (location #44), the Taylor River (location #53) and Willow Creek (location #64) all recorded excessive mercury for the DWS-C2 at one time or another. Two locations on the Crystal River and one on the North Fork of the Crystal River (locations #13, #14 and #11 respectively) showed excessive sulphate for DWS-C2. A site near Gunnison (location #32) and one near Paonia Reservoir (location #40) showed excessive ammonia. Five sites were classified REC-C1.

Table 2. CLASSIFICATION OF STREAM SEGMENTS INCLUDED IN THE BASE LINE STUDY

| SITE | 1974 CLASSIFICATION | JULY, 1978 CLASSIFICATION |
|---|---|---|
| Anthracite Ck. (ACO1) | $A_1$ (exc FS) | CWB-C1; DWS-C2; |
| Big Blue Ck. (BBO1) | $B_1$ | CWB-C1; DWS-C2; |
| Cebolla Ck.-1 CEBO1 | $A_1$ (exc FS) | CWB-C1, DWS-C2; |
| Cebolla Ck.-2 CEBO2 | $A_1$ (exc FS) | CWB-C1 (exc Al); DWS-C2; |
| Cement Ck. CEMCKO1 | $B_1$ | CWB-C1; DWS-C2; |
| Cochetopa Ck. CHACKO1 | $B_1$ | CWB-C1 (exc $NH_3$); DWS-C2 (exc Mn); |
| Coal Ck. COACKO1 | $A_1$ | REC-C1; |
| Coal Ck. CCNFO1 | $A_1$ (exc FS) | CWB-C1; DWS-C2; |
| Crystal Ck. CRYO1 | $A_1$ | CWB-C1 (exc Al); DWS-C2; |
| East River ERO1 | $A_1$ | CWB-C1; DWS-C2; |
| Gold Ck.-1 GCO1 | $A_1$ | CWB-C1 (exc Zn); DWS-C2; |
| Gold Ck.-2 GCO2 | $A_1$ | CWB-C1; DWS-C2; |
| Gunnison River GRO1 | $B_1$ | CWB-C1 (exc $NH_3$); DWS-C2; |
| Hot Springs Ck. HSCKO1 | $B_1$ | CWB-C1 (exc Al); DWS-C2 (exc Mn & F);* |
| Lake Fork Gunnison River LFGO1 | $A_1$ (exc FS) | CWB-C1 (exc Al & $NH_3$); DWS-C2; |
| Little Blue Ck. LBO1 | $A_1$ (exc FS) | CWB-C1 (exc Al); DWS-C2 |

*Fluoride is natural in this water from a hot spring.

(continued)

Table 2. (continued)

| SITE | 1974 CLASSIFICATION | JULY, 1978 CLASSIFICATION |
|---|---|---|
| Muddy Ck.<br>MC01 | $B_1$ | REC-C2;** |
| North Fork Gunnison River<br>NFG01 | $A_1$ (exc FS) | CWB-C1 (exc Al & $NH_3$); DWS-C2; |
| Oh-Be-Joyful Ck.<br>OBJ01 | $A_1$ | CWB-C1 (exc Al & Zn); DWS-C2; |
| Ohio Ck.<br>OHC01 | $B_1$ | CWB-C1; DWS-C2; |
| Quartz Ck.-1<br>QC01 | $A_1$ | CWB-C1; DWS-C2; |
| Quartz Ck.-2<br>QC02 | $A_1$ | CWB-C1; DWS-C2; |
| Slate River -1<br>SR01 | $A_1$ (exc FS) | CWB-C1; DWS-C2 (exc Mn); |
| Slate River -2<br>SR02 | $A_1$ (exc FS) | CWB-C1; DWS-C2; |
| Slate River -3<br>SR03 | $A_1$ | CWB-C1 (exc Zn); DWS-C2 (exc Mn); |
| Taylor River -1<br>TR01 | $A_1$ | CWB-C1; DWS-C2; |
| Taylor River -2<br>TR02 | $A_1$ | CWB-C1; DWS-C2; |
| Texas Ck.<br>TEXC01 | $A_1$ | CWB-C1; DWS-C2; |
| Tomichi Ck.-1<br>TC01 | $A_1$ (exc FS) | CWB-C1; DWS-C2 (exc Mn); |
| Tomichi Ck.-2<br>TC02 | $B_1$ | CWB-C1; DWS-C2 (exc Mn); |
| Tomichi Ck.-3<br>TC03 | $A_1$ (exc FS) | CWB-C1; DWS-C2; |
| Willow Ck.<br>WC01 | $A_1$ | CWB-C1; DWS-C2; |

**Heavy natural suspended solids produce an apparent high metal content.

Table 3. CLASSIFICATION OF STREAM SEGMENTS FROM STORET DATA.

| LOCATION NUMBER | LOCATION | 1974 CLASSIFICATION | JULY, 1978 CLASSIFICATION |
|---|---|---|---|
| 1 | Blue Mesa Reservoir | $A_1$ | CWB-C1; DWS-C2; |
| 2 | Blue Mesa Reservoir | $A_1$ | CWB-C1 (exc DO); DWS-C2; |
| 3 | Carbon Creek | $A_1$ | CWB-C1; DWS-C2; |
| 4 | Cement Creek | $A_1$ | CWB-C1; DWS-C2; |
| 5 | Coal Creek/Crested Butte | $A_1$ | REC-C1; |
| 6 | Coal Creek above Keystone Mine | $A_1$ | CWB-C1; DWS-C2; |
| 7 | Coal Creek/Irwin | $A_1$ | DWS-C2 (exc Pb & Fe) |
| 8 | Coal Creek/Wildcat Creek | $B_1$ | REC-C1; |
| 9 | Coal Creek/Elk Creek | $A_1$ | DWS-C1 (exc Pb & Zn); |
| 10 | Coal Creek/Crystal River | $A_1$ | CWB-C1; DWS-C2; |
| 11 | No. Fork Crystal River | $A_1$ | CWB-C1; DWS-C2 (exc $SO_4$); |
| 12 | So. Fork Crystal River | $A_1$ | CWB-C1 (exc Hg); DWS-C2; |
| 13 | Crystal River | $A_1$ | CWB-C1; DWS-C2 (exc $SO_4$); |
| 14 | Crystal River | $A_1$ | CWB-C1; DWS-C2 (exc $SO_4$); |
| 15 | Crystal River | $A_1$ | CWB-C1; DWS-C2; |
| 16 | Crystal River | $A_1$ | CWB-C1; DWS-C2; |

(continued)

Table 3. (continued)

| LOCATION NUMBER | LOCATION | 1974 CLASSIFICATION | JULY, 1978 CLASSIFICATION |
|---|---|---|---|
| 17 | East River | $A_1$ | DWS-C2; |
| 18 | East River | $A_1$ | CWB-C1; DWS-C2; |
| 19 | East River | $A_1$ | CWB-C1; DWS-C2; |
| 20 | East River | $A_1$ | CWB-C1; DWS-C2; |
| 21 | East River | $A_1$ | CWB-C1; DWS-C2; |
| 22 | East River | $A_1$ | CWB-C1; DWS-C2; |
| 23 | Gunnison River | $B_1$ | CWB-C1; DWS-C2; |
| 24 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 25 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 26 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 27 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 28 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 29 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 30 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 31 | Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 32 | Gunnison River | $B_1$ | CWB-C1 (exc $NH_3$); DWS-C2; |



(continued)

Table 3. (continued)

| LOCATION NUMBER | LOCATION | 1974 CLASSIFICATION | JULY, 1978 CLASSIFICATION |
|---|---|---|---|
| 33 | Gunnison River | $B_1$ | CWB-C1; DWS-C2; |
| 34 | Gunnison River | $A_1$ | CWB-C1(exc Hg); DWS-C2(exc Mn); |
| 35 | Hot Springs Creek | $B_1$ | CWB-C1; DWS-C2; |
| 37 | Lake Fork Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 38 | Lake Fork Gunnison River | $A_1$ | CWB-C1; DWS-C2; |
| 39 | Oh-Be-Joyful Creek | $A_1$ | DWS-C2 (exc Pb & Zn); |
| 40 | Paonia Reservoir | $A_1$ | CWB-C1 (exc $NH_3$); DWS-C2; |
| 41 | Middle Quartz Creek | $A_1$ | CWB-C1 (exc Hg); DWS-C2; |
| 42 | Quartz Creek | $A_1$ | CWB-C1; DWS-C2; |
| 43 | Quartz Creek | $A_1$ | CWB-C1; DWS-C2; |
| 44 | Cement Creek | $A_1$ | CWB-C1; DWS-C2; |
| 45 | Sanford Creek | $A_1$ | CWB-C1 (exc Hg); DWS-C2; |
| 46 | Slate River | $A_1$ | REC-C1; |
| 47 | Slate River | $A_1$ | CWB-C1 (exc Cd); DWS-C2; |
| 48 | Slate River | $A_1$ | CWB-C1; DWS-C2; |
| 49 | Slate River | $A_1$ | DWS-C2 (exc Pb & Zn); |

(continued)

Table 3. (concluded)

| LOCATION NUMBER | LOCATION | 1974 CLASSIFICATION | JULY, 1978 CLASSIFICATION |
|---|---|---|---|
| 50 | Slate River | $A_1$ | REC-C1; |
| 51 | Slate River | $A_1$ | REC-C1; |
| 52 | Slate River | $A_1$ | CWB-C1; DWS-C2; |
| 54 | Slate River | $A_1$ | DWS-C2 (exc Zn); |
| 55 | Taylor River | $A_1$ | CWB-C1 (exc Hg); DWS-C2; |
| 56 | Taylor River | $A_1$ | CWB-C1; DWS-C2; |
| 57 | Taylor River | $A_1$ | CWB-C1; DWS-C2; |
| 58 | Taylor River | $A_1$ | CWB-C1; DWS-C2; |
| 59 | Tomichi Creek | $B_1$ | DWS-C2; |
| 60 | Tomichi Creek | $A_1$ | CWB-C1; DWS-C2; |
| 61 | Tomichi Creek | $A_1$ | CWB-C1; DWS-C2; |
| 62 | Tomichi Creek | $A_1$ | CWB-C1; DWS-C2; |
| 63 | Tomichi Creek | $A_1$ | CWB-C1; DWS-C2; |
| 64 | Tomichi Creek | $A_1$ | CWB-C1; DWS-C2; |
| 65 | Waunita Hot Springs | $A_1$ | CWB-C1; DWS-C2; |
| 66 | Willow Creek | $A_1$ | CWB-C1 (exc Hg); DWS-C2; |

PARAMETERS OF WATER QUALITY

Note: In the following discussion, each parameter measured in the base line study will be considered in terms of range of individual measurements, averages, and notable exceptions to the average values. Results obtained from other studies will then be considered. Refer to maps showing site locations, Figures 1 and 2, pages 8 and 9 to locate indicated sites. The Appendix tables and figures applicable to each parameter are listed at the beginning of the discussion of each parameter. The Appendix tables list range, average and standard deviation (where determined) for each parameter at each site.

Dissolved Oxygen (DO) (Appendix: Table A-1, Fig. A-1, Table A-11)

All stations in the base line study had at least 6 milligrams per liter (mg/l) required for placement in the Colorado $A_1$ Classification. Values ranged from 7.1 to 12.6 mg/l. Appendix Table A-1 gives data for DO at individual sampling stations. There is no consistent pattern of increasing or decreasing DO in streams travelling from stations at higher elevations to stations at lower elevations, evidenced by examining Appendix Figure A-1. These oxygen levels place waters in the 1974 Class $A_1$ and in the 1978 classes Cold Water Biota Class 1 (CWB-C1), Domestic Water Supply Class 2 (DWS-C2), Recreation Class 1 (REC-C1) and Agricultural (AGR).

Data available in STORET showed that 212 measurements of DO averaged 8.1 mg/l, with values ranging from 5.3 to 10.4 mg/l. The only measured sites with values below 6, which is the minimum acceptable value for classes $A_1$ and CWB-C1, were on Blue Mesa Reservoir.

Biochemical Oxygen Demand ($BOD_5$) (Appendix: Table A-1, Fig. A-2, Table A-11)

Values ranged from less than 1 to 6.2 mg/l. The average of 112 measurements available through other sources was 1.4 mg/l with a range of 1.17 to 1.63 mg/l. $BOD_5$ is not included as a criteria for any classification, however, a value over 5 mg/l is considered a possible pollution indicator. Values of 5.0 mg/l or more were found in nine of 264 measurements: TC03 (3), TC02 (1), GR01 (2), ER01 (1), LFG01 (1), NFG01 (1). However, the highest average value for any site was 3.7 mg/l at TC02.

Total Coliform (Appendix: Table A-1, Fig. A-3, Table A-11)

Geometric mean values ranged from 8 to 1,807 col/100 ml for sites in the present study and all sites met the $A_1$ classification criteria of a geometric mean of less than 1,000 col/100 ml, except MC01, OH01 and TC02. Total Coliform is not used as a criteria for any 1978 classification. The 219 measurements available through other data were taken at four locations - one on Taylor River at Almont and one on the East River at Almont, both of which have averages of less than 500 col/100 ml. The other two locations, one on Gunnison River west of Gunnison and Tomichi Creek, had averages over 4,000 col/100 ml.

Fecal Coliform (Appendix: Table A-1, Fig. A-4, Table A-11)

Geometric means for sites in the present study ranged from 2 to 283 col/100 ml. Those over the $A_1$ classification limit were MC01 and TC02. The 1978 standards classification REC-C1 limit of 200 col/100 ml was exceeded only by MC01. The DWS-C2 and AGR limit of 1,000 col/100 ml was not exceeded at any site. Data from other sources had 248 measurements with an average of 356 col/100 ml and a range of 0 to 1,087 col/100 ml. There were two sites, one on Gunnison River and one on Tomichi Creek, which measured a total of 110 times with unusually high counts. Without those two stations the average value would be 61 col/100 ml, with only 5 of the remaining 138 measurements being in excess of 100 col/100 ml.

Fecal Streptococcus (Appendix: Table A-1, Fig. A-5, Table A-11)

All sites in the present study except COACK01, CRY01, GC01, GC02, LFG01, QC01, QC02, SR03, TR01, TR02, TEXC01 and WC01 had geometric mean values greater than the $A_1$ limit of 20 col/100 ml, however the high values were distributed over a very brief period of time and were not descriptive of the general nature of the stream. Other sources of data provided only 18 values. They were taken from points in the Crested Butte-Gunnison-Pitkin area in June and July, 1974. The values ranged from 13 to 595 col/100 ml with an average of 221 col/100 ml. They were single samples, therefore not providing a geometric mean and taken during the peak time for fecal streptococcus concentrations and therefore not representative of overall stream quality. Fecal streptococcus is not used in the 1978 classification scheme.

Temperature (Appendix: Table A-2, Fig. A-6, Table A-11)

Class $A_1$ temperature criteria is specified in terms of temperature rise caused by discharges into a stream. So far as is known, there are no warming discharges into county streams. Therefore, normal diurnal and seasonal fluctuations are assumed to be maintained and the diurnal temperatures were not monitored in this study. The highest temperature was measured on Hot Springs Creek (HSCK01) at 70°F; the lowest, 31°F on Tomichi Creek (TC01). Average temperatures on the various sites cannot be directly compared because some averages represent sites whose temperatures were measured all year long and some only spring, summer and fall. However, the averages ranged from 39°F at COACK01 to 61°F at HSCK01.

Although diurnal temperatures were not monitored in this study, a previous study conducted at Mountain Meadow Research Center (unpublished data) included monitoring the diurnal fluctuations on Ohio Creek over a period of the six months May through September, 1971, which showed the largest changes in temperature to be 20°F in May (34° to 54°) and August (50° to 70°), and the least 15° (53° to 68°) in July. One is tempted to assume winter temperatures would show less change, since air temperatures stay below freezing for long periods of time.

Of the total 264 temperature measurements made, only six were over 68°F (20°C); five of those were 69°F and one 70°F, placing the entire system of streams in the Cold Water Biota Class.

pH (Appendix: Table A-2, Fig. A-7, Table A-11)

Values on sites in the present study ranged from 6.5 to 10.7 SU, with a total of 59 (22%) of the 264 readings being greater than 8.5 SU. With the exception of CEMCK01 and CHACK01 any average pH over 8.5 SU was produced by one (in the case of stations measured only three times) or several high values which occurred, almost exclusively, during spring run-off in May and June. These values, because of the limited time of occurrence were not considered to be descriptive of the quality of water and were not included in classification estimates. $A_1$ class waters may have a range of 6.5 to 8.5 SU; $B_1$, REC-C1 and CWB-C1 classes 6.5 to 9.0 SU, and DWS-C2 5.0 to 9.0 SU. There were 34 pH measurements over 9.0 SU falling in the same pattern as the over 8.5 SU measurements.

Other data included 374 measurements ranging from 5.6 to 8.8 SU, average 7.9 SU. Three measurements fell below the 6.5 SU limit, all three on Coal Creek near the confluence with the Keystone Mine effluent. The effluent itself measured 3.0 SU. Seven other relatively low values occurred on Slate River and Coal Creek.

Conductivity (Appendix: Table A-2, Fig. A-8, Table A-11)

Conductivities ranged from 45 μmhos at COACK01 to 715 μmhos at HSCK01. HSCK01 conductivity measurements were considerably higher than those at other sites due to hot springs source. Twenty-seven other sites had average conductance values of less than 300 μmhos.

Other data reviewed listed 403 measurements of conductivity with a range of 50 to 890 μmhos. Conductivity is not used in the criteria of any of the classifications, however, the relatively low values indicate generally low concentrations of dissolved salts (.01 M KCl has a conductivity of 1,408 μmhos at 25°C).

Suspended Solids (Appendix: Table A-2, Fig. A-9, Table A-11)

Suspended solids values found in the present study ranged from less than .1 mg/l to 122 mg/l on all sites except MC01 where the range was 294 to 1,708 mg/l. Average values, except at MC01 and WC01, were 17 mg/l or less. Other data provided 126 measurements with a range of 3.0 to 24 mg/l and an average of 14 mg/l. Those values came exclusively from the Gunnison River and tributaries north of the river's confluence with Tomichi Creek. Measurements from the same area in this study averaged approximately 6 mg/l. Although suspended solids is not a criteria for any current classification it had been suggested that 25 mg/l be used as a criteria for CWB-C1. (Proposed Water Quality Standards, October 28, 1976).

Stream Velocity (Appendix: Table A-2, Fig. A-10, Table A-11)

Stream velocities were measured from May through December. At a given site, the variation in velocity was less than .1 ft/sec in many cases; the largest variation was 1.7 ft/sec. There was no general "high" flow period with respect to time of year. (It was not deemed practical to measure volume of stream flow in our year-long study. In addition, 1977 was a drouth year.) Velocity is not used as a criteria for any classification.

Total Ammonia ($NH_4^+$+$NH_3$)-N (Appendix: Table A-3, Fig. A-11, Table A-11)

Actual measured values shown in tables and figures were total ammonia, ($NH_4^+$+$NH_3$)-N values, from which unionized ammonia ($NH_3$-N) values were calculated. As a pollution indicator this material should not be over .5 mg/l to meet DWS-C2 criteria. The values found in this study varied from .08 to 1.02 mg/l. The 22 high values were found no more than twice at any station and no average value was over 0.40 mg/l. A similar pattern was found in other studies.

Unionized ammonia values ranged from less than .001 to .090 mg/l with values over the .02 mg/l limit for CWB-C1 in 54 (20%) of the measurements made in this study. Of those, 10 occurred at NFG01, 9 at GR01, 5 at LFG01 and 4 at TC01. Other over-the-limit values were distributed randomly among the other sites. All sites, other than those on the highest streams, such as WC01, TEXC01, AC01, TR02, GC02 and QC02. OBJ01 and SR02 would probably have high unionized ammonia values if sampled frequently over the summer. High values were restricted to summer and except for GR01 and NFG01 occurred over such a short time period so as not to be considered descriptive. All averages were less than 0.02 mg/l. There is no other classification for which unionized $NH_3$-N is used as a criteria.

Nitrate-nitrogen (diss) (Appendix: Table A-3, Fig. A-12, Table A-11)

The nitrate-nitrogen values found in this study ranged from less than .01 to .54 mg/l, with averages ranging from .07 to .23 mg/l. Those in other studies had a range of 0.08 to 1.0 mg/l and an average of .49 mg/l. The criteria for DWS-C2 is 10 mg/l and for AGR is 100 mg/l. No sites studied were over the limits.

Phosphate-phosphorus (Appendix: Table A-3, Fig. A-13, Table A-11)

No specific numerical criteria is used for this parameter. The range found in this study is 0.00 to 0.20 mg/l with averages ranging from 0.00 to 0.12 mg/l. The range found in other data reviewed was 0.006 to 4.71 mg/l with an average of .33 mg/l. These measurements included two sets of samples taken at sites 32 and 33 known as point sources of pollution. For the other 94 samples representing 18 sites, the average was less than 0.01 mg/l.

Total Kjeldahl Nitrogen (TKN) (Appendix: Table A-3, Fig. A-14, Table A-11)

The range found in this study was from .2 to 2.5 mg/l with averages ranging from .4 to 1.4 mg/l. TKN in 86 samples from other studies ranged from .02 to 11.2 mg/l with an average of 1.2 mg/l. This parameter is not used in classification.

Sodium (total) (Appendix: Table A-4, Fig. A-15, Table A-11)

In this study, with one exception, values ranged from 1.0 to 18.0 mg/l. Averages ranged from 1.0 mg/l at OBJ01, SR02 and GC02 to 16.5 mg/l at CHACK01. HSCK01 was exceptional where the range was 82.0 to 143.0 mg/l with an average of 112 mg/l. Other studies provided data with 185 total sodium measurements with a range of 2.6 to 8.9 mg/l and an average of 5.2 mg/l. There is no classification with a criteria for this parameter.

Potassium (total) (Appendix: Table A-4, Fig. A-16, Table A-11)

The sites in this study had a range of less than 1.0 to 8.0 mg/l with averages ranging from less than 1.0 mg/l at numerous sites to 6.5 mg/l at HSCK01. Other studies recorded 13 measurements with a range of 0.00 to 10.00 mg/l with an average of 4.7 mg/l. There is no classification with a criteria for this parameter.

Calcium (total) (Appendix: Table A-4, Fig. A-17, Table A-11)

The sites in this study have a range of 7.0 mg/l at OBJ01 to 74 mg/l at CRY01 with averages ranging from 9.5 mg/l at OBJ01 to 55.0 mg/l at OHC01. Other data had 29 measurements with a range of 5 to 170 mg/l and an average of 29.7 mg/l. There is no classification with a criteria for this parameter.

Magnesium (total) (Appendix: Table A-4, Fig. A-18, Table A-11)

The sites in this study have a range of 1.0 mg/l at 5 sites to 18.0 mg/l at TC02, with averages ranging from 1.0 mg/l at OBJ01 to 14.5 mg/l at TC01. Other data did not provide a comparable measurement. There is no classification with a criteria for this parameter.

Sulfate (diss) (Appendix: Table A-5, Fig. A-19, Table A-11)

Sulfate values varied from 1.2 mg/l at WC01 to 144 mg/l at CRY01, with averages ranging from 3.2 mg/l at WC01 and 87.4 mg/l at CRY01. Other data sources had 35 measurements ranging from 5.0 mg/l to 30.0 mg/l with an average of 13.8 mg/l. DWS-C2 limit is 250 mg/l.

Fluoride (diss) (Appendix: Table A-5, Fig. A-20, Table A-11)

Fluoride values ranged from .066 mg/l at CCNF01 to 16.1 mg/l at HSCK01 with averages ranging from .070 mg/l at SR02 to 9.6 mg/l at HSCK01. Other data provided 13 measurements ranging from 0.10 mg/l to 18.00 mg/l with an average of 1.55 mg/l. The 18 mg/l value was measured at Waunita Hot Springs (the source of HSCK01) and is the only value of those in this group over 0.300 mg/l. Therefore, a more realistic average, omitting that value, is 0.179 mg/l. The classification DWS-C2 limit varies from 2.4 mg/l to 1.4 mg/l at various temperatures. The only sites over the limit are HSCK01 and Waunita Hot Springs.

Chloride (diss) (Appendix: Table A-5, Fig. A-21, Table A-11)

Chloride values ranged from 0.9 mg/l at TR01 to 16.4 mg/l at HSCK01 with averages ranging from 1.6 mg/l at WC01 and CEMCK01 to 13.8 mg/l at HSCK01. The second highest average value was 3.2 mg/l at TC02. Other sources provided 229 measurements with a range of 0.20 to 10.0 mg/l with an average of 4.7 mg/l. DWS-C2 limit is 250 mg/l.

Boron (total) (Appendix: Table A-5, Fig. A-22, Table A-11)

Boron values ranged from 10 to 30 µg/l at all sites in this study except at HSCK01 where the values were from 30 to 60 µg/l. Averages ranged from 10 to 20 µg/l except at HSCK01 where the average was 45 µg/l. Boron samples from other data provided measurements of boron ranging from 7.1 to 19.5 µg/l with an average of 11.6 µg/l. The only classification limit is 750 µg/l. All measurements were well below this limit.

Aluminum (total) (Appendix: Table A-6, Fig. A-23, Table A-11)

Aluminum values ranged from less than 50 to 605 µg/l at all sites in this study except at MC01 where the values were 3,380 to 5,100 µg/l. Average values ranged from less than 50 µg/l to 505 µg/l. If the average value at a site was greater than 120 µg/l or both values over 100 µg/l an aluminum (Al) exception was noted for the classification CWB-C1 designation. Other sources provided no aluminum measurements. The limit for aluminum is 100 µg/l for CWB-C1.

Arsenic (total) (Appendix: Table A-6, Fig. A-24, Table A-11)

Arsenic values on sites in this study ranged from less than .5 µg/l to 8.0 µg/l. Forty-three of the 64 measurements were less than .5 µg/l. Other data provided 119 total arsenic measurements all given a value of 0.00 µg/l. The limit for classes CWB-C1 and DWS-C2 is 50 µg/l, and for AGR 100 µg/l. All measurements were well below these limits.

Cadmium (total) (Appendix: Table A-6, Table A-11)

Cadmium values for this study were all recorded simply as less than 5 µg/l because of limitations in instrument sensitivity. This allows cadmium to be included in the classification estimates for DWS-C2 and AGR, whose limits are 10 µg/l, but not in that for CWB-C1, whose limit, at the hardness of most streams in this study, is 0.4 µg/l.

Total cadmium data from other sources provides 114 measurements with a range of 0.00 to 0.18 µg/l. All measurements were 0.00 except at one site on the East River, location 17, where the average of 27 measurements was 0.18 µg/l. The available dissolved cadmium data is more generally distributed over the county with a total of 36 measurements, of which 18 are less than .4 µg/l. The other 18 were taken in the Keystone mine area at sites affected by its seepage. Those values ranged from 0.870 to 57 µg/l.

Chromium (total) (Appendix: Table A-6, Table A-11)

Chromium measurements were recorded as less than 5 µg/l or less than 10 µg/l, because of instrument limitations. However, because the CWB-C1 and AGR limits are 100 µg/l and DWS-C2 limit is 50 µg/l all sites are clearly below these limits. Data from other sources included 126 measurements and indicate finding no chromium.

Copper (total) Appendix: Table A-6, Fig. A-25, Table A-11)

Copper measurements ranged from less than 5 µg/l to 17 µg/l. Averages ranged from less than 5 µg/l at 19 locations to 17 µg/l at MC01. Only four of the 64 measurements were over the CWB-C1 classification limit of 10 µg/l and no average value except a 16 µg/l average at MC01 was over the limit. DWS-C2 and AGR limits are 1,000 µg/l and 200 µg/l respectively. Data available from other sources provide 138 measurements with a range of 0.00 to 275 µg/l with an average of 8.5 µg/l. The six higher than 10 µg/l values were on Coal Creek (locations 8 and 5), Oh-Be-Joyful (location 38) and Slate River (location 48). (Keystone Mine again!)

Iron (total) (Appendix: Table A-7, Fig. A-26, Table A-11)

Iron measurements ranged from 38 µg/l at GC02 to 939 µg/l at HSCK01, except MC01 where the values were 3,190 and 3,614 µg/l. The averages were 42 µg/l at GC02 to 742 µg/l at HSCK01, except MC01 where the average is 3,402 µg/l.

Data from other sources provides 195 measurements with a range of 60 to 3,800 µg/l and an average of 271 µg/l. The CWB-C1 limit is 1,000 µg/l. The eleven values over 1,000 µg/l were all on Coal Creek and Slate River. The Keystone Mine effluent measures 32,000 µg/l.

Classification DWS-C2 has a soluble iron limit of 300 ug/l. Although soluble iron was not measured in this study, dissolved iron values available from 36 measurements in other data ranged from 10 µg/l at five sites to 1,400 µg/l at Coal Creek (location 7). The average was 139 µg/l with only two sites (locations 7 and 8) over 300. This data in combination with the low total iron values indicate that with the exception of MC01 and HSCK01, sites in this study meet the DWS-C2 limits on soluble iron.

Manganese (total) (Appendix: Table A-7, Fig. A-27, Table A-11)

Values for manganese ranged from 2 µg/l at TEXC01 and GC02 to 791 µg/l at SR03. Averages ranged from 2 µg/l at TEXC01 to 559 µg/l at SR03. The CWB-C1 limit is 1,000 µg/l; AGR 200 µg/l, and DWS-C2 50 (sol) µg/l. With the exception of MC01, SR03 and TC02 all sites were within the AGR limits, and all meet the CWB-C1 limits. Other data, including 188 measurements ranged from less than 13 to 11,195 µg/l with an average of 278 µg/l. The seven values over the AGR 200 µg/l limit are found at Coal Creek and Slate River locations. No soluble manganese values were available, therefore direct assessment for DWS-C2 was impossible, however, if a site was given a DWS-C2 classification but had a total value of over 50 µg/l it was noted with a manganese exception.

Lead (total) (Appendix: Table A-7, Table A-11)

All sites in this study had less than 30 µg/l. Values were measured to less than 30 µg/l because of instrument limitations. CWB-C1 limit is 4 µg/l, DWS-C2 50 µg/l, and AGR 100 µg/l. Data from other sources had 126 measurements ranging from 0.00 to 11.3 µg/l with an average of 4.0 µg/l. The high values were found on Tomichi Creek (location 57). (Dissolved lead values were generally out of limits for CWB-C1 in the Keystone Mine area and two out of 34 measured over 100 µg/l in that area.)

Zinc (total) (Appendix: Table A-7, Fig. A-28, Table A-11)

Zinc values ranged from less than 2 µg/l at nine sites in this study to 889 µg/l at SR03. Averages ranged from 2 µg/l at CEB02 to 652 µg/l at SR03. All sites met the AGR 2,000 µg/l limit and DWS-C2 5,000 µg/l limit. Six sites failed to meet the 50 µg/l CWB-C1 limit. Of those four were affected by Keystone Mine effluent - OBJ01, SR01, SR03 and COACK01. The other two were TR02 and GC02 each with one high value and one very low value.

Other data available had 181 values ranging from 5.6 to 8,050 µg/l. The high (over 50 µg/l) values were found at nine sites in the Coal Creek-Slate River - Oh-Be-Joyful Creek area affected by Keystone Mine effluent. The effluent was measured at 100,000 µg/l dissolved zinc.

Sediment Analyses (Appendix Tables A-8, A-9 and A-10)

These show mineral and metals content for sediments from the sites sampled in this study. Although there are no specific limits placed on the parameters, the measurements indicate that under extreme conditions - including extremely low pH and high temperatures - iron, manganese, lead and copper could become general problems. However, these conditions are unlikely to occur if mining and ore processing activities in the area are controlled in accordance with State and Federal requirements.

Other parameters from other studies

Many other parameters are listed in Table A-11 that may be helpful in making a general assessment of the overall water quality in Gunnison County.

In particular, the high value of 6 µg/l for selenium on a total of 8 dissolved and 122 total selenium determinations is well below the most stringent criteria (100 µg/l for DWS-C2) established.

Seventy-two silver analyses showed one value of .9 µg/l. The rest were 0.00 µg/l. The most stringent limit is 10 µg/l for DWS-C2.

Total molybdenum measured on 58 samples had a high value of 1.6 µg/l. There is no present established limit, however, molybdenum concentrations are a matter of concern to ranchers, particularly in view of the possible opening of a large molybdenum mine in the area.

Forty-six mercury values ranged from 0.00 to 1.0 µg/l with only one value over 0.3 µg/l (at Willow Creek). The CWB-C1 0.5 µg/l limit is the most stringent for all classifications.

Forty-three dissolved alpha measurements were made, two were over the 15 PC/L limit, but the error in measurement was so large that in each case the actual value could have been well below that limit.

Twenty-four dissolved beta measurements were made, all less than 19 PC/L. The limit is 50 PC/L.

Radium 226 was measured on eight samples. The maximum reading was .58 PC/L. The limit is 5 PC/L.

PROBLEM AREAS

The major source of poor quality water in this area is effluent from the Keystone Mine, which causes considerable pollution by metals in areas of Coal Creek, Slate River and Oh-Be-Joyful Creek.

The other major problem is the increase in ammonia and pH content on Onio Creek, Tomichi Creek, Cochetopa Creek, Lake Fork of the Gunnison River, North Fork of the Gunnison River and the Gunnison River during late spring, although this seems to be distinctly seasonal and of short duration.

# APPENDIX

Appendix Tables A-1 through A-7 give range, average values and standard deviations for parameters measured in this study.

Appendix Figures A-1 through A-28 give the same data shown at site locations so that variations from site to site on a given water course can be examined.

Appendix Tables A-8, A-9 and A-10 show mineral and heavy metals content for sediment from the sites in this study.

Appendix Table A-11 gives county-wide average values for data available through other studies of surface water in this area. The values are listed by STORET parameter numbers to indicate the analytical procedures used in their measurement.

Table A-1. BIOLOGICAL PARAMETERS

| SITE | DO mg/l | $BOD_5$ mg/l | *Total Coliform col/100 ml | *Fecal Coliform col/100 ml | *Fecal Strep col/100 ml |
|---|---|---|---|---|---|
| ACO1 | 8.1-10.6<br>8.9 | <2-4.6<br>3.0 | 20-100<br>34 | <1-20<br>7 | 36-150<br>60 |
| BBO1 | 8.4-11.2<br>9.4 | <2-4.8<br>3.0 | 48-875<br>276 | 2-231<br>24 | 42-275<br>142 |
| CEBO1 | 6.5-11.4<br>9.2(1.6) | <1-3.6<br>2.4(.7) | 17-450<br>119(165) | 1-140<br>17(43) | 10-750<br>68(207) |
| CEBO2 | 7.4-10.7<br>8.9 | 2.3-4.1<br>3.0 | 103-150<br>119 | 9-112<br>37 | 37-110<br>57 |
| CEMCKO1 | 8.4-9.2<br>8.8 | <2-2.1<br>2.0 | 3-115<br>15 | <1-10<br>4 | 11-175<br>57 |
| CHACKO1 | 7.4-9.3<br>8.4 | <2-2.3<br>2.1 | 370-2,450<br>920 | 7-278<br>89 | 56-475<br>230 |
| COACKO1 | 8.0-10.7<br>9.4(.9) | <2-3.3<br>2.2(.5) | <1-370<br>12(104) | <1-36<br>3(9.8) | <1-65<br>3(19.7) |
| CCNFO1 | 8.6-10.8<br>9.4 | 1.5-3.4<br>2.8 | 8-100<br>22 | 1-10<br>2 | 21-185<br>45 |
| CRYO1 | 8.4-8.8<br>8.6 | <2-3.2<br>2.6 | 20-200<br>43 | 5-25<br>10 | 6-50<br>20 |
| ERO1 | 7.1-12.0<br>9.7(1.3) | <1-5.8<br>2.6(1.2) | <1-1,050<br>66(266) | <1-114<br>4(23.8) | <1-330<br>24(94.6) |
| GCO1 | 8.3-10.0<br>8.9 | <1-2.1<br>2.0 | 1-45<br>8 | <1-2<br>1 | 6-20<br>13 |
| GCO2 | 7.8-10.0<br>8.8 | <1-4.8<br>2.6 | 7-35<br>12 | <1-<1<br>1 | <1-11<br>3.8 |
| GRO1 | 7.2-12.6<br>9.9(1.5) | <2-5.4<br>3.3(1.0) | <1-1,550<br>63(348) | <1-97<br>8(26) | 15-1,310<br>115(264) |
| HSCKO1 | 6.8-8.2<br>7.4 | 1.4-2.0<br>1.8 | 90-4,600<br>853 | <1-285<br>30 | 90-345<br>150 |
| LFGO1 | 7.2-11.8<br>9.7(1.4) | <2-5.0<br>2.8(1.0) | <1-555<br>29(157) | <1-30.0<br>3(45) | 2-720<br>20(160) |
| LBO1 | 8.2-11.1<br>9.3 | 2.2-4.5<br>3.0 | 66-500<br>181 | 1-70<br>16 | 45-300<br>85 |

(continued)

*mean values are geometric rather than arithmetic means for these three parameters.

Table A-1. (continued)

| SITE | DO mg/l | $BOD_5$ mg/l | *Total Coliform col/100 ml | *Fecal Coliform col/100 ml | *Fecal Strep col/100 ml |
|---|---|---|---|---|---|
| MC01 | 8.0-9.1<br>8.7 | < 2-4.2<br>3.3 | 120-8,250<br>1,189 | 120-970<br>283 | 150-875<br>395 |
| NFG01 | 7.8-11.9<br>10.0(1.4) | < 2-6.0<br>3.2(1.1) | 4-1,540<br>93(347) | < 1-98<br>9(22) | 1-735<br>39(152) |
| OBJ01 | 7.6-9.1<br>8.6 | < 1-3.8<br>2.3 | 35-64<br>48 | 3-11<br>6 | 10-55<br>22 |
| OHC01 | 7.3-8.4<br>8.0 | < 2-3.6<br>2.7 | 400-8,200<br>1,807 | 10-70<br>29 | 65-800<br>243 |
| QC01 | 8.2-9.9<br>9.0 | < 2-2.5<br>2.2 | 4-320<br>42 | 1-14<br>2 | < 1-137<br>15 |
| QC02 | 8.6-10.5<br>9.3 | < 2-2.7<br>2.4 | 2-100<br>23 | < 1-1<br>1 | 2-82<br>19 |
| SR01 | 7.8-10.5<br>9.4(.9) | < 2-4.2<br>2.0(.9) | < 1-330<br>25(124) | < 1-40<br>5(16) | 2-141<br>36(44) |
| SR02 | 7.7-9.2<br>8.6 | < 1-3.1<br>2.0 | 53-125<br>87 | < 1-95<br>12 | 18-135<br>51 |
| SR03 | 8.3-11.0<br>9.3(.9) | < 2-2.6<br>2.2(.4) | < 1-250<br>19(93) | < 1-50<br>6(22) | < 1-110<br>15(34) |
| TR01 | 8.7(11.5<br>10.0(1.0) | < 2-3.6<br>2.6(.5) | < 1-1,200<br>30(348) | < 1-11<br>2(4.1) | < 1-83<br>6(24.7) |
| TR02 | 7.9-9.2<br>8.7 | < 1-2<br>1.6 | 9-60<br>23 | < 1-44<br>4 | 1-25<br>8 |
| TEXC01 | 8.0-9.0<br>8.6 | < 1-2<br>1.6 | 8-121<br>29 | < 1-14<br>2 | < 1-20<br>3 |
| TC01 | 8.9-12.4<br>10.0(1.3) | < 2-6.2<br>3.1(1.2) | < 2-2,750<br>221(820) | < 1-370<br>24(121) | 12-450<br>98(146) |
| TC02 | 7.7-10.2<br>8.8 | 2.2-5.5<br>3.7 | 340-7,500<br>1,359 | 99-425<br>164 | 110-2,150<br>452 |
| TC03 | 7.8-11.2<br>9.5(1.0) | < 2-4.1<br>2.4(.8) | 5-3,080<br>166(1,104) | < 1-1,050<br>15(296) | 11-TNTC<br>68(175) |
| WC01 | 8.2-9.2<br>8.7 | < 1-< 2<br>< 2 | 21-330<br>101 | 1-108<br>9 | 5-85<br>20 |

*mean values are geometric rather than arithmetic means for these three parameters.

Table A-2. PHYSICAL PARAMETERS

| SITE | Temp. °F | pH std. units | Conductivity µmhos/cm | Suspended solids mg/l | Velocity ft/sec |
|---|---|---|---|---|---|
| AC01 | 41-61<br>51 | 8.0-8.7<br>8.3 | 98-148<br>121 | .4-9.9<br>4.1 | 1.9-2.9<br>2.3 |
| BB01 | 35-58<br>46 | 7.8-10.1<br>8.6 | 84-146<br>124 | 2.0-5.1<br>3.5 | 1.1-2.2<br>1.6 |
| CEB01 | 33-67<br>45.2(13.7) | 7.2-8.6<br>7.8(.4) | 100-340<br>158(62.8) | 1.2-52.6<br>11.5(14.3) | 1.1-2.8<br>1.9(.5) |
| CEB02 | 35-56<br>46 | 8.0-9.4<br>8.6 | 86-138<br>109 | 2.6-8.9<br>6.4 | 1.9-2.0<br>1.9 |
| CEMCK01 | 39-54<br>44 | 8.7-10.3<br>9.3 | 240-310<br>286 | 1.5-8.6<br>4.7 | 1.1-1.9<br>1.5 |
| CHACK01 | 47-62<br>55 | 8.6-9.3<br>9.0 | 280-384<br>317 | 1.1-33.9<br>13.5 | 1.6-3.2<br>2.4 |
| COACK01 | 32-52<br>38.6(7.6) | 6.4-10.4<br>7.8(1.0) | 45-200<br>121(66.5) | .2-11.0<br>2.9(2.8) | 1.1-2.2<br>1.5(.5) |
| CCNF01 | 44-59<br>51 | 8.3-10.5<br>9.1 | 100-132<br>114 | .7-9.8<br>5.2 | 1.6-2.6<br>2.0 |
| CRY01 | 41-49<br>44 | 7.7-8.7<br>8.2 | 144-395<br>291 | 2.4-17.4<br>11.8 | 1.9-4.0<br>2.6 |
| ER01 | 32-64<br>43.5(10.0) | 8.1-10.3<br>8.6(.6) | 108-350<br>291(53.7) | .2-50.6<br>6.6(10.7) | 1.9-4.3<br>2.6(.8) |
| GC01 | 42-54<br>48 | 8.2-10.7<br>9.1 | 128-132<br>130 | .4-7.8<br>5.1 | 1.6-1.9<br>1.7 |
| GC02 | 42-49<br>47 | 7.8-10.7<br>8.9 | 72-96<br>83 | .3-.8<br>.6 | 1.1-1.1<br>1.1 |
| GR01 | 32.5-69<br>46(12.9) | 7.2-10.6<br>8.7(.7) | 170-324<br>243(40.2) | 1.2-93.6<br>13.5(18.6) | 2.0-4.3<br>2.7(.5) |
| HSCK01 | 52-70<br>61 | 8.2-8.6<br>8.4 | 576-715<br>642 | 7.1-28.6<br>17.1 | 1.1-1.1<br>1.1 |
| LFG01 | 31-69<br>43.5(12.4) | 7.5-9.4<br>8.2(.36) | 120-188<br>160(17) | .2-122<br>16.0(29) | 1.6-4.0<br>2.4(.7) |
| LB01 | 34-59<br>46 | 7.9-8.4<br>8.2 | 98-100<br>99 | 4.2-6.9<br>5.4 | 1.1-1.6<br>1.3 |



(continued)

Table A-2. (continued)

| SITE | Temp. °F | pH std. units | Conductivity µmhos/cm | Suspended solids mg/l | Velocity ft/sec |
|---|---|---|---|---|---|
| MC01 | 49-55<br>51 | 8.2-9.0<br>8.5 | 195-264<br>230 | 294-1,708<br>794 | 1.6-1.6<br>1.6 |
| NFG01 | 32-67<br>45(11.8) | 7.5-10.4<br>8.6(0.7) | 78-260<br>157(36) | <.1-34.8<br>10.0(9.0) | 1.1-3.5<br>2.2(.6) |
| OBJ01 | 39-48<br>44 | 8.1-9.3<br>8.7 | 49-82<br>69 | 1.8-2.4<br>2.1 | 1.1-3.0<br>1.7 |
| OHC01 | 49-65<br>59 | 8.3-8.7<br>8.5 | 330-400<br>367 | .4-12.8<br>5.1 | 1.1-1.6<br>1.3 |
| QC01 | 35-53<br>46 | 8.0-10.7<br>9.1 | 149-193<br>167 | .4-7.2<br>2.4 | 1.9-3.5<br>2.7 |
| QC02 | 42-49<br>45 | 8.2-10.6<br>9.1 | 102-149<br>126 | 1.8-2.8<br>2.2 | 1.9-2.9<br>2.3 |
| SR01 | 32-63<br>43(11.0) | 7.2-9.2<br>8.1(.5) | 84-220<br>176(48) | .3-21.6<br>6.0(7.0) | 1.6-3.8<br>2.3(1.1) |
| SR02 | 39-54<br>45 | 8.2-10.0<br>8.9 | 62-140<br>109 | 2.5-10.7<br>7.3 | 1.6-3.5<br>2.3 |
| SR03 | 32-62<br>46(12) | 7.9-8.4<br>8.1(.16) | 87-195<br>145(44) | .7-15.8<br>5.0(5.0) | 1.1-3.2<br>1.7(.7) |
| TR01 | 32-59<br>41(8.8) | 7.6-10.7<br>8.6(.8) | 109-158<br>132(19.3) | <.1-6.7<br>3.2(2.2) | 2.2-2.9<br>2.5(.4) |
| TR02 | 37-54<br>45 | 8.1-8.5<br>8.3 | 82-122<br>105 | 1.5-12.4<br>5.7 | 1.6-2.9<br>2.2 |
| TEXC01 | 40-54<br>46 | 7.9-8.3<br>8.1 | 56-76<br>65 | .8-8.9<br>3.9 | 1.6-2.9<br>2.3 |
| TC01 | 31-69<br>46(13.4) | 7.1-10.7<br>8.4(.7) | 219-440<br>310(60) | 2.2-44.1<br>9.3(10.4) | 1.1-2.6<br>2.0(.4) |
| TC02 | 50-62<br>55 | 7.4-8.5<br>8.0 | 450-564<br>495 | 3.0-23.9<br>11.7 | 1.6-2.5<br>1.9 |
| TC03 | 32-56<br>40(9.2) | 7.8-10.3<br>8.2(.7) | 107-240<br>162(46.3) | 1.1-74.0<br>10.6(20) | 1.1-1.6<br>1.4(.3) |
| WC01 | 40-53<br>46 | 8.0-8.3<br>8.1 | 127-148<br>134 | 1.9-87.4<br>31.0 | 1.1-2.2<br>1.6 |

Table A-3. NUTRIENT CONTENT

| SITE | $NH_3$-N ppm | $NO_3^-$-N ppm | $PO_4^{-3}$-P ppm | TKN ppm |
|---|---|---|---|---|
| AC01 | .15-.22<br>.18 | .04-.16<br>.07 | .00-.01<br>.01 | .7-1.1<br>.9 |
| BB01 | .30-.59<br>.46 | .10-.34<br>.18 | .05-.11<br>.08 | .7-1.5<br>1.2 |
| CEB01 | .01-.78<br>.36(.20) | .01-.37<br>.14(.12) | .04-.07<br>.05(.01) | .2-.9<br>.7 |
| CEB02 | .09-.68<br>.29 | .04-.30<br>.16 | .05-.06<br>.05 | .2-1.2<br>.1 |
| CEMCK01 | .29-.49<br>.40 | .01-.26<br>.11 | .00-.00<br>.00 | .7-1.1<br>.9 |
| CHACK01 | .26-.46<br>.37 | .08-.35<br>.23 | .07-.20<br>.12 | .8-1.0<br>.9 |
| COACK01 | .02-.73<br>.34(.19) | .01-.33<br>.10(.09) | .00-.12<br>.02(.03) | .0-1.2<br>.8 |
| CCNF01 | .14-.22<br>.19 | .02-.10<br>.09 | .00-.02<br>.01 | .7-2.5<br>1.3 |
| CRY01 | .20-.42<br>.30 | .02-.19<br>.08 | .00-.01<br>.00 | .6-.9<br>.8 |
| ER01 | .02-.66<br>.30(.15) | <.01-.14<br>.11(.08) | .00-.06<br>.02(.01) | .7-1.7<br>.8 |
| GC01 | .04-.63<br>.37 | .10-.34<br>.20 | .00-.01<br>.01 | .6-.8<br>.7 |
| GC02 | .15-.64<br>.38 | .06-.22<br>.16 | .00-.00<br>.00 | .2-1.0<br>.6 |
| GR01 | .01-.59<br>.33(.18) | <.01-.27<br>.12(.09) | .01-.04<br>.02(.01) | 1.1-1.5<br>1.2 |
| HSCK01 | .02-.41<br>.18 | .20-.26<br>.23 | .05-.09<br>.07 | 1.0-1.9<br>1.4 |
| LFG01 | .07-1.02<br>.27(.20) | .01-.57<br>.11(.13) | .01-.05<br>.03(.01) | .4-1.7<br>.9 |
| LB01 | .29-.56<br>.39 | .06-.19<br>.12 | .02-.06<br>.03 | .7-1.5<br>1.0 |

(continued)

Table A-3. (continued)

| SITE | $NH_3$-N ppm | $NO_3^-$-N ppm | $PO_4^{-3}$-P ppm | TKN ppm |
|---|---|---|---|---|
| MC01 | .08-.29<br>.19 | .05-.20<br>.14 | .02-.04<br>.03 | .7-1.0<br>.9 |
| NFG01 | .16-.98<br>.32(.19) | <.01-.22<br>.10(.06) | .00-.03<br>.02(.01) | .4-.8<br>.6 |
| OBJ01 | .18-.29<br>.23 | .01-.15<br>.08 | .00-.00<br>.00 | .7-1.1<br>.9 |
| OHC01 | .17-.45<br>.34 | .20-.52<br>.31 | .01-.02<br>.01 | .5-.8<br>.7 |
| QC01 | .18-.66<br>.38 | .06-.22<br>.13 | .01-.03<br>.02 | .4-.9<br>.6 |
| QC02 | .17-.67<br>.37 | .12-.20<br>.15 | .00-.03<br>.01 | .3-.7<br>.5 |
| SR01 | .16-.90<br>.39(.24) | <.01-.54<br>.16(.17) | <.01-.08<br>.01(.02) | .4-.7<br>.6 |
| SR02 | .15-.42<br>.29 | .00-.08<br>.04 | .00-.01<br><.01 | .5-.8<br>.6 |
| SR03 | .08-.87<br>.36(.24) | .01-.12<br>.06(.04) | <.01-.02<br>.01(.01) | .1-.8<br>.4 |
| TR01 | .08-.63<br>.29(.15) | <.01-.20<br>.07(.07) | .00-.01<br>.01(.00) | <.5-.7<br>.6 |
| TR02 | .12-.38<br>.26 | .10-.20<br>.15 | .00-.01<br>.00 | .3-1.3<br>.8 |
| TEXC01 | .04-.18<br>.12 | .06-.24<br>.14 | .00-.01<br>.00 | <.5-1.0<br>.8 |
| TC01 | .04-.83<br>.38(.21) | <.01-.23<br>.12(.06) | <.01-.04<br>.02(.01) | .6-1.4<br>.9 |
| TC02 | .12-.75<br>.51 | .10-.40<br>.21 | .03-.20<br>.09 | .7-1.6<br>1.2 |
| TC03 | .03-.58<br>.30(.17) | <.01-.48<br>.15(.14) | <.01-.04<br>.02(.01) | .4-1.0<br>.8 |
| WC01 | .07-.42<br>.35 | .10-.20<br>.13 | .00-.02<br>.01 | .1-1.0<br>.8 |

Table A-4. MINERAL CONTENT - WATER - Part I

| SITE | Na mg/l | K mg/l | Ca mg/l | Mg mg/l |
|---|---|---|---|---|
| ACO1 | 2.0-4.0<br>3.0 | <1.0-1.0<br>1.0 | 12.0-42.0<br>27.0 | 2.0-3.0<br>2.5 |
| BBO1 | 3.0-5.0<br>4.0 | 2.0-2.0<br>2.0 | 10.0-15.0<br>12.5 | 3.0-4.0<br>3.5 |
| CEBO1 | 10.0-12.0<br>11.0 | 3.0-3.0<br>3.0 | 17.0-20.0<br>18.5 | 4.0-5.0<br>4.5 |
| CEBO2 | 3.0-5.0<br>4.0 | 2.0-3.0<br>2.5 | 11.0-15.0<br>13.0 | 2.0-3.0<br>2.5 |
| CEMCKO1 | 2.0-4.0<br>3.0 | 1.0-1.0<br>1.0 | 45.0-52.0<br>48.0 | 12.0-15.0<br>13.5 |
| CHACKO1 | 15.0-18.0<br>16.5 | 3.0-4.0<br>3.5 | 43.0-53.0<br>48.0 | 8.0-9.0<br>8.5 |
| COACKO1 | 1.0-3.0<br>2.0 | <1.0-1.0<br>1.0 | 8.0-16.0<br>12.0 | 1.0-2.0<br>1.5 |
| CCNFO1 | 5.0-6.0<br>5.5 | <1.0-1.0<br>1.0 | 13.0-14.0<br>13.5 | 3.0-3.0<br>3.0 |
| CRYO1 | 1.0-2.0<br>1.5 | <1.0-<1.0<br><1.0 | 24.0-74.0<br>49.0 | 3.0-7.0<br>5.0 |
| ERO1 | 4.0-4.0<br>4.0 | <1.0-1.0<br>1.0 | 45.0-55.0<br>50.0 | 8.0-10.0<br>9.0 |
| GCO1 | 1.0-2.0<br>1.5 | <1.0-<1.0<br><1.0 | 16.0-17.0<br>16.5 | 6.0-6.0<br>6.0 |
| GCO2 | 1.0-1.0<br>1.0 | <1.0-<1.0<br><1.0 | 9.0-11.0<br>10.0 | 4.0-5.0<br>4.5 |
| GRO1 | 4.0-7.0<br>5.5 | 1.0-2.0<br>1.5 | 35.0-50.0<br>42.5 | 8.0-12.0<br>10.0 |
| HSCKO1 | 82.0-143.0<br>112.0 | 5.0-8.0<br>6.5 | 12.0-16.0<br>14.0 | 2.0-4.0<br>3.0 |
| LFGO1 | 3.0-5.0<br>4.0 | <1.0-1.0<br><1.0 | 18.0-25.0<br>21.5 | 3.0-4.0<br>3.5 |
| LBO1 | 4.0-4.0<br>4.0 | 1.0-2.0<br>1.5 | 11.0-12.0<br>11.5 | 2.0-3.0<br>2.5 |

(continued)

Table A-4. (continued)

| SITE | Na mg/l | K mg/l | Ca mg/l | Mg mg/l |
|---|---|---|---|---|
| MC01 | 10.0-11.0<br>10.5 | 2.0-2.0<br>2.0 | 43.0-57.0<br>50.0 | 9.0-11.0<br>10.0 |
| NFG01 | 3.0-6.0<br>4.5 | < 1.0-< 1.0<br>< 1.0 | 11.0-17.0<br>14.0 | 2.0-3.0<br>2.5 |
| OBJ01 | 1.0-1.0<br>1.0 | < 1.0-< 1.0<br>< 1.0 | 7.0-12.0<br>9.5 | 1.0-1.0<br>1.0 |
| OHC01 | 6.0-6.0<br>6.0 | 1.0-3.0<br>2.0 | 54.0-56.0<br>55.0 | 13.0-14.0<br>13.5 |
| QC01 | 2.0-2.0<br>2.0 | < 1.0-1.0<br>< 1.0 | 22.0-28.0<br>25.0 | 6.0-8.0<br>7.0 |
| QC02 | 2.0-2.0<br>2.0 | < 1.0-1.0<br>< 1.0 | 16.0-21.0<br>18.5 | 4.0-5.0<br>4.5 |
| SR01 | 2.0-5.0<br>3.5 | < 1.0-1.0<br>< 1.0 | 14.0-33.0<br>23.5 | 2.0-6.0<br>4.0 |
| SR02 | 1.0-1.0<br>1.0 | < 1.0-< 1.0<br>< 1.0 | 12.0-22.0<br>17.0 | 1.0-2.0<br>1.5 |
| SR03 | 2.0-7.0<br>4.5 | < 1.0-1.0<br>< 1.0 | 14.0-23.0<br>18.5 | 2.0-4.0<br>3.0 |
| TR01 | 2.0-2.0<br>2.0 | < 1.0-1.0<br>< 1.0 | 15.0-20.0<br>17.5 | 5.0-6.0<br>5.5 |
| TR02 | 2.0-2.0<br>2.0 | 1.0-1.0<br>1.0 | 11.0-17.0<br>14.5 | 3.0-5.0<br>4.0 |
| TEXC01 | 1.0-2.0<br>1.5 | < 1.0-< 1.0<br>< 1.0 | 9.0-11.0<br>10.0 | 1.0-2.0<br>1.5 |
| TC01 | 9.0-10.0<br>9.5 | 2.0-3.0<br>2.5 | 53.0-54.0<br>53.5 | 14.0-15.0<br>14.5 |
| TC02 | 7.0-24.0<br>15.5 | 1.0-3.0<br>2.0 | 14.0-55.0<br>34.5 | 6.0-18.0<br>12.0 |
| TC03 | 3.0-4.0<br>3.5 | 1.0-1.0<br>1.0 | 18.0-18.0<br>18.0 | 4.0-5.0<br>4.5 |
| WC01 | 2.0-2.0<br>2.0 | 1.0-1.0<br>1.0 | 18.0-23.0<br>20.5 | 4.0-5.0<br>4.5 |

Table A-5. MINERAL CONTENT - WATER - Part II

| SITE | $SO_4^{-2}$ ppm | $F^-$ ppm | $Cl^-$ ppm | B ug/l |
|---|---|---|---|---|
| ACO1 | 5.4-15.0<br>10.5 | .120-.146<br>.129 | 1.6-2.4<br>1.9 | 20-20<br>20 |
| BBO1 | 4.9-9.8<br>7.3 | .101-.132<br>.122 | 1.8-2.4<br>2.1 | 10-20<br>15 |
| CEBO1 | 7.4-19.4<br>10.6(3.2) | .160-.740<br>.339(.184) | 1.4-5.0<br>3.0(1.6) | 30-30<br>30 |
| CEBO2 | 7.8-11.2<br>10.1 | .120-.144<br>.130 | 1.4-1.9<br>1.6 | 10-10<br>10 |
| CEMCKO1 | 12.2-33.2<br>22 | .101-.171<br>.144 | 1.2-2.1<br>1.7 | 10-10<br>10 |
| CHACKO1 | 5.5-24.1<br>13.7 | .360-.620<br>.510 | 1.3-4.6<br>2.7 | 20-20<br>20 |
| COACKO1 | 6.4-82.4<br>27.0(18.0) | <.100-.420<br>.282(.109) | 1.3-3.0<br>2.2(.6) | 10-10<br>10 |
| CCNFO1 | 4.7-7.3<br>6.0 | .066-.078<br>.072 | 1.5-1.9<br>1.7 | 10-20<br>15 |
| CRYO1 | 21.3-144<br>87.4 | .130-.263<br>.210 | 1.7-2.4<br>2.0 | 10-10<br>10 |
| ERO1 | 16.3-45.5<br>26.7(6.7) | <.100-.225<br>.168(.030) | 1.6-2.6<br>2.0(.30) | 10-10<br>10 |
| GCO1 | 3.6-6.5<br>5.2 | .170-.285<br>.230 | 2.0-2.4<br>2.3 | 10-10<br>10 |
| GCO2 | 3.3-4.4<br>3.7 | .130-.160<br>.150 | 1.5-2.4<br>2.1 | 10-10<br>10 |
| GRO1 | 8.4-21.4<br>14.5(3.2) | .180-.346<br>.239(.040) | 1.4-2.6<br>1.9(.4) | 10-20<br>15 |
| HSCKO1 | 86.5-142.9<br>120 | 3.80-16.1<br>9.6 | 9.1-16.4<br>13.8 | 30-60<br>45 |
| LFGO1 | 15.4-31.0<br>26.3(4.4) | .200-.350<br>.257(.038) | 1.4-2.9<br>2.1(.45) | 10-10<br>10 |
| LBO1 | 4.2-4.4<br>4.3 | .118-.130<br>.120 | 1.6-2.7<br>2.2 | 10-10<br>10 |

(continued)

Table A-5. (continued)

| SITE | $SO_4^{-2}$ ppm | $F^-$ ppm | $Cl^-$ ppm | B ug/l |
|---|---|---|---|---|
| MC01 | 6.0-6.4<br>6.2 | .160-.235<br>.210 | 1.8-2.6<br>2.1 | 20-20<br>20 |
| NFG01 | 5.3-23.6<br>8.5(3.7) | <.100-.240<br>.140(.040) | 1.6-5.0<br>2.4(1.0) | 10-10<br>10 |
| OBJ01 | 4.0-10.9<br>6.5 | .070-.105<br>.090 | 1.5-2.5<br>1.9 | 10-10<br>10 |
| OHC01 | 11.2-22.4<br>17.3 | .230-.280<br>.250 | 2.0-2.4<br>2.1 | 20-20<br>20 |
| QC01 | 5.2-7.6<br>6.7 | .140-.163<br>.150 | 1.8-2.1<br>2.0 | 10-10<br>10 |
| QC02 | 5.1-8.5<br>6.9 | .130-.142<br>.140 | 1.9-2.2<br>2.0 | 10-10<br>10 |
| SR01 | 8.6-34.4<br>27.0(8.0) | .120-.410<br>.210(.090) | 1.3-2.3<br>1.9(.34) | 10-10<br>10 |
| SR02 | 9.4-29.4<br>16.4 | .070-.077<br>.070 | 2.1-2.4<br>2.2 | 10-10<br>10 |
| SR03 | 8-41<br>29(12) | <.100-.420<br>.270(.130) | 1.3-3.4<br>2.0(.64) | 10-10<br>10 |
| TR01 | 4.3-7.6<br>5.9(.9) | .130-.203<br>.170(.022) | .9-2.0<br>1.7(.33) | 10-10<br>10 |
| TR02 | 2.0-10.4<br>6.1 | .200-.264<br>.231 | 1.9-2.5<br>2.1 | 10-10<br>10 |
| TEXC01 | 3.6-4.9<br>4.2 | <.100-.120<br>.120 | 1.5-2.4<br>1.9 | 10-10<br>10 |
| TC01 | 6-26<br>15(5) | .210-.560<br>.404(.088) | 1.4-3.4<br>2.2(.5) | 20-20<br>20 |
| TC02 | 39.3-99.0<br>59.3 | .890-1.20<br>1.06 | 1.3-4.3<br>3.2 | 10-30<br>20 |
| TC03 | 7.2-21.5<br>10.0(4.0) | .220-.372<br>.267(.045) | 1.6-2.5<br>2.0(.4) | 10-10<br>10 |
| WC01 | 1.2-4.9<br>3.2 | .073-.101<br>.090 | 1.2-2.0<br>1.6 | 10-10<br>10 |

Table A-6. HEAVY METALS - WATER - Part I
Total Concentrations

| SITE | Al µg/l | As µg/l | Cd µg/l | Cr µg/l | Cu µg/l |
|---|---|---|---|---|---|
| ACO1 | 77-92<br>84 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5-16<br>10 |
| BBO1 | <50-173<br>112 | 0.5-0.8<br>0.6 | <5- <5<br><5 | <5- <10<br><5 | <5-7<br>6 |
| CEBO1 | <50-162<br>106 | 5.0-6.5<br>5.8 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| CEBO2 | 99-162<br>130 | <.5 <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5-5<br><5 |
| CEMCKO1 | <50-64<br>57 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| CHACKO1 | <50-72<br>61 | 6.2-8.0<br>7.1 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| COACKO1 | 231-241<br>236 | 3.5-3.7<br>3.6 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br>5 |
| CCNFO1 | <50-188<br>119 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| CRYO1 | 123-130<br>126 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5-7<br>6 |
| ERO1 | <50- <50<br><50 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| GCO1 | <50- <50<br><50 | 1.4-2.8<br>2.1 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| GCO2 | <50- <50<br><50 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| GRO1 | <50-114<br>82 | <.5-.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| HSCKO1 | 406-605<br>505 | <.5-.7<br>.6 | <5- <5<br><5 | <5- <10<br><5 | <5-6<br>5 |
| LFGO1 | <50-300<br>175 | .7-.7<br>.7 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| LBO1 | 100-162<br>131 | .7-.9<br>.8 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |

(continued)

Table A-6. (continued)

| SITE | Al µg/l | As µg/l | Cd µg/l | Cr µg/l | Cu µg/l |
|---|---|---|---|---|---|
| MC01 | 3,380-5,100<br>4,240 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | 14-17<br>16 |
| NFG01 | 110-275<br>192 | <.5-.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| OBJ01 | 109-218<br>163 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | 5-11<br>8 |
| OHC01 | <50- <50<br><50 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| QC01 | <50-95<br>70 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| QC02 | <50- <50<br><50 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5-8<br>6 |
| SR01 | <50-243<br>150 | <.5-1.2<br>.8 | <5- <5<br><5 | <5- <10<br><5 | <5-7<br>6 |
| SR02 | 87-122<br>104 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5-6<br>5 |
| SR03 | 65-241<br>153 | <.5-1.2<br>.8 | <5- <5<br><5 | <5- <10<br><5 | <5-8<br>6 |
| TR01 | <50- <50<br><50 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| TR02 | 63-113<br>86 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| TEXC01 | <50- <50<br><50 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| TC01 | <50- <50<br><50 | 1.1-1.3<br>1.2 | <5- <5<br><5 | <5- <10<br><5 | <5-9<br>7 |
| TC02 | <50-70<br><60 | <.5-.8<br>.6 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| TC03 | <50-64<br>57 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5- <5<br><5 |
| WC01 | <50-100<br>75 | <.5- <.5<br><.5 | <5- <5<br><5 | <5- <10<br><5 | <5-7<br>6 |

Table A-7. HEAVY METALS - WATER - Part II
Total Concentrations

| SITE | Fe µg/l | Mn µg/l | Pb µg/l | Zn µg/l |
|---|---|---|---|---|
| AC01 | 76-156<br>116 | 7-11<br>9 | < 30-< 30<br>< 30 | < 2-14<br>7 |
| BB01 | 310-346<br>328 | 34-50<br>42 | < 30-< 30<br>< 30 | < 2-7<br>4 |
| CEB01 | 488-515<br>502 | 43-53<br>48 | < 30-< 30<br>< 30 | 3-71<br>37 |
| CEB02 | 180-411<br>295 | 16-29<br>22 | < 30-< 30<br>< 30 | 2-2<br>2 |
| CEMCK01 | 73-181<br>127 | 10-15<br>12 | < 30-< 30<br>< 30 | < 2-13<br>7 |
| CHACK01 | 309-367<br>338 | 42-60<br>51 | < 30-< 30<br>< 30 | < 2-8<br>5 |
| COACK01 | 161-224<br>192 | 63-111<br>87 | < 30-< 30<br>< 30 | 225-273<br>249 |
| CCNF01 | 130-220<br>175 | 7-16<br>12 | < 30-< 30<br>< 30 | < 2-7<br>4 |
| CRY01 | 206-235<br>220 | 13-19<br>16 | < 30-< 30<br>< 30 | 5-50<br>28 |
| ER01 | 46-90<br>68 | 8-39<br>24 | < 30-< 30<br>< 30 | 12-58<br>35 |
| GC01 | 75-83<br>79 | 4-7<br>5 | < 30-< 30<br>< 30 | 19-220<br>119 |
| GC02 | 38-45<br>42 | 2-5<br>4 | < 30-< 30<br>< 30 | 3-10<br>6 |
| GR01 | 80-252<br>166 | 27-67<br>47 | < 30-< 30<br>< 30 | 6-28<br>17 |
| HSCK01 | 546-939<br>742 | 52-60<br>56 | < 30-< 30<br>< 30 | 4-17<br>10 |
| LFG01 | 49-367<br>208 | 14-68<br>41 | < 30-< 30<br>< 30 | 41-43<br>42 |
| LB01 | 312-348<br>330 | 16-21<br>18 | < 30-< 30<br>< 30 | < 2-8<br>5 |

(continued)

Table A-7.(continued)

| SITE | Fe µg/l | Mn µg/l | Pb µg/l | Zn µg/l |
|---|---|---|---|---|
| MC01 | 3,190-3,614<br>3,402 | 166-396<br>281 | < 30-35<br>32 | 38-39<br>38 |
| NFG01 | 201-362<br>281 | 10-23<br>16 | < 30-< 30<br>< 30 | 2-16<br>9 |
| OBJ01 | 126-128<br>127 | 40-61<br>50 | < 30-< 30<br>< 30 | 160-463<br>312 |
| OHC01 | 123-131<br>127 | 22-77<br>50 | < 30-< 30<br>< 30 | < 2-18<br>10 |
| QC01 | 74-320<br>197 | 5-21<br>13 | < 30-< 30<br>< 30 | 4-9<br>6 |
| QC02 | 190-195<br>192 | 9-13<br>11 | < 30-30<br>< 30 | 3-11<br>7 |
| SR01 | 91-402<br>246 | 106-279<br>192 | < 30-< 30<br>< 30 | 206-378<br>292 |
| SR02 | 168-192<br>180 | 5-8<br>6 | < 30-< 30<br>< 30 | 11-13<br>12 |
| SR03 | 145-349<br>247 | 327-791<br>559 | < 30-< 30<br>< 30 | 415-889<br>652 |
| TR01 | 137-214<br>176 | 24-39<br>32 | < 30-< 30<br>< 30 | 3-11<br>7 |
| TR02 | 166-744<br>455 | 6-26<br>16 | < 30-< 30<br>< 30 | 8-291<br>150 |
| TEXC01 | 94-111<br>102 | 2-3<br>2 | < 30-< 30<br>< 30 | < 2-5<br>3 |
| TC01 | 237-285<br>261 | 56-110<br>83 | < 30-< 30<br>< 30 | 3-16<br>10 |
| TC02 | 176-524<br>350 | 53-463<br>258 | < 30-< 30<br>< 30 | < 2-14<br>8 |
| TC03 | 352-575<br>461 | 23-38<br>30 | < 30-< 30<br>< 30 | 20-26<br>23 |
| WC01 | 360-360<br>360 | 24-33<br>28 | < 30-< 30<br>< 30 | 6-23<br>14 |

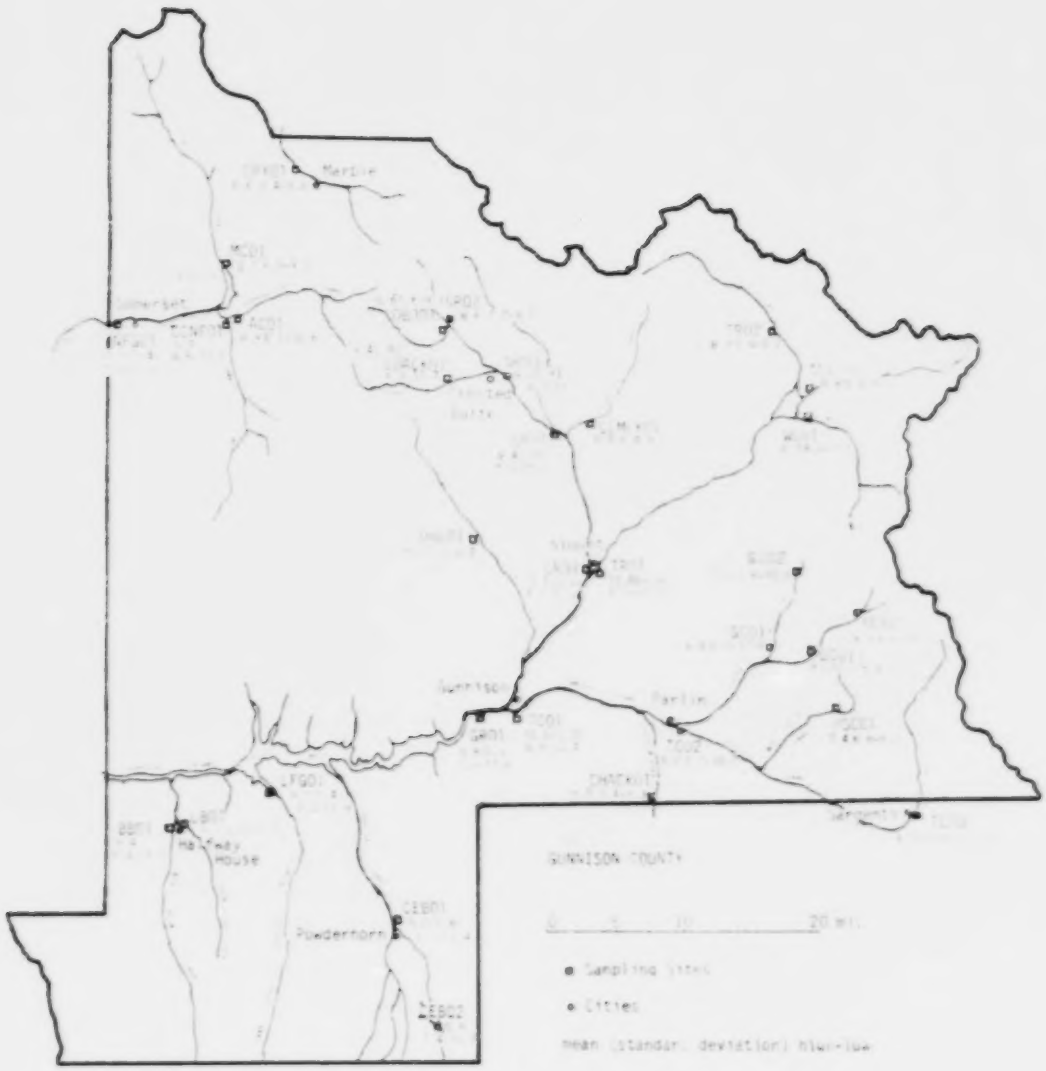


Figure A-1. Dissolved Oxygen Content of Surface Waters

Figure 5-11. Biochemical Oxygen Demand (mg/l) Content of Surface Waters

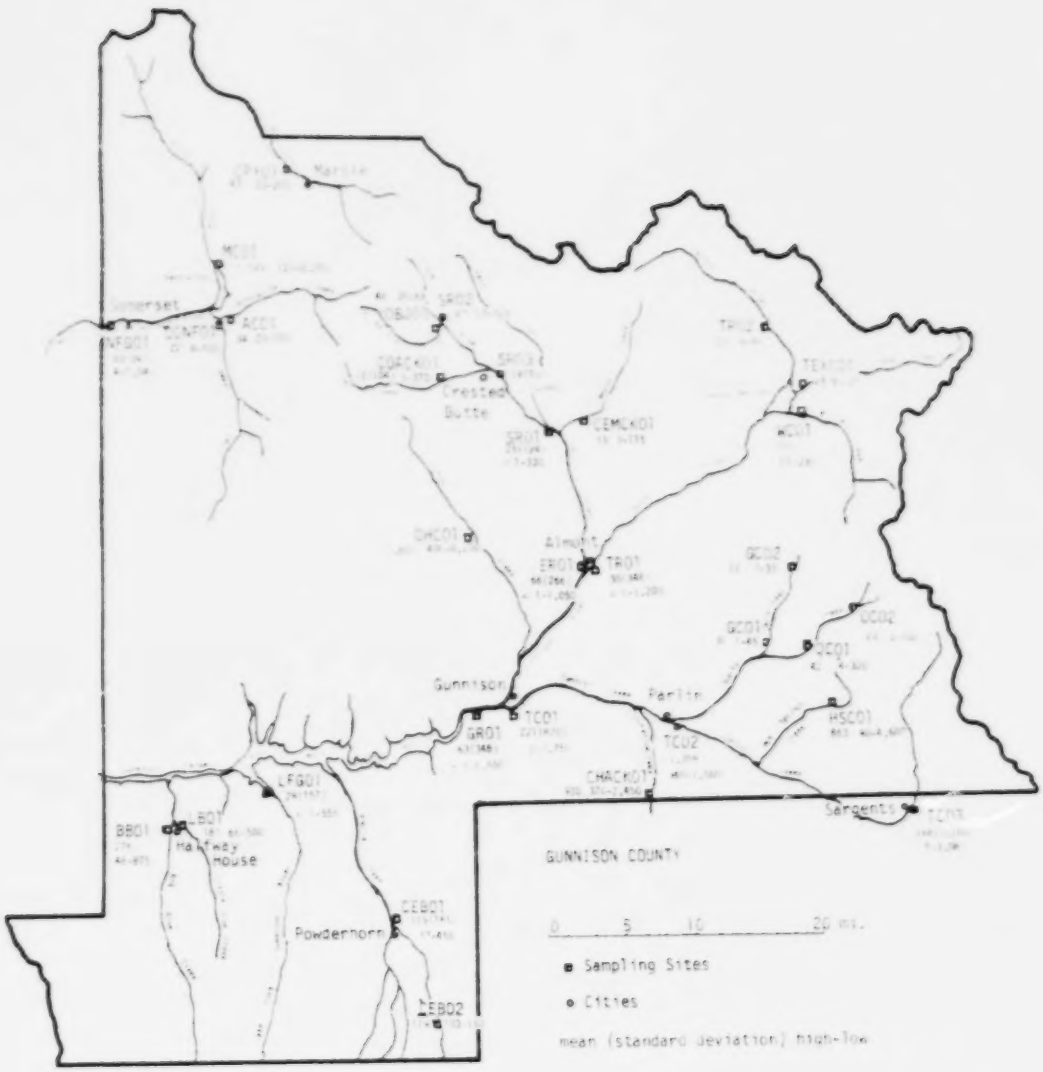


Figure 4-3. Total Coliform

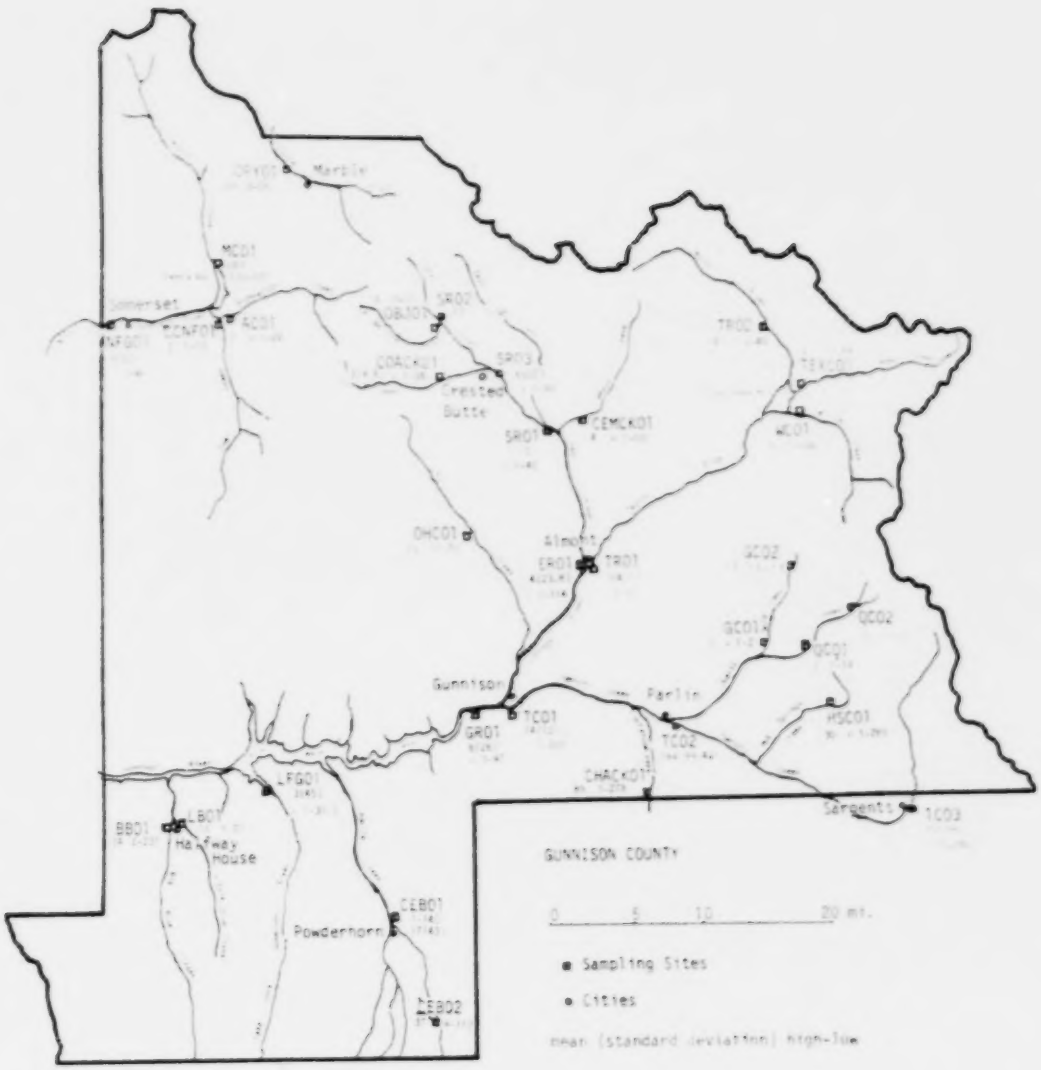


Figure A-4. Fecal Coliform

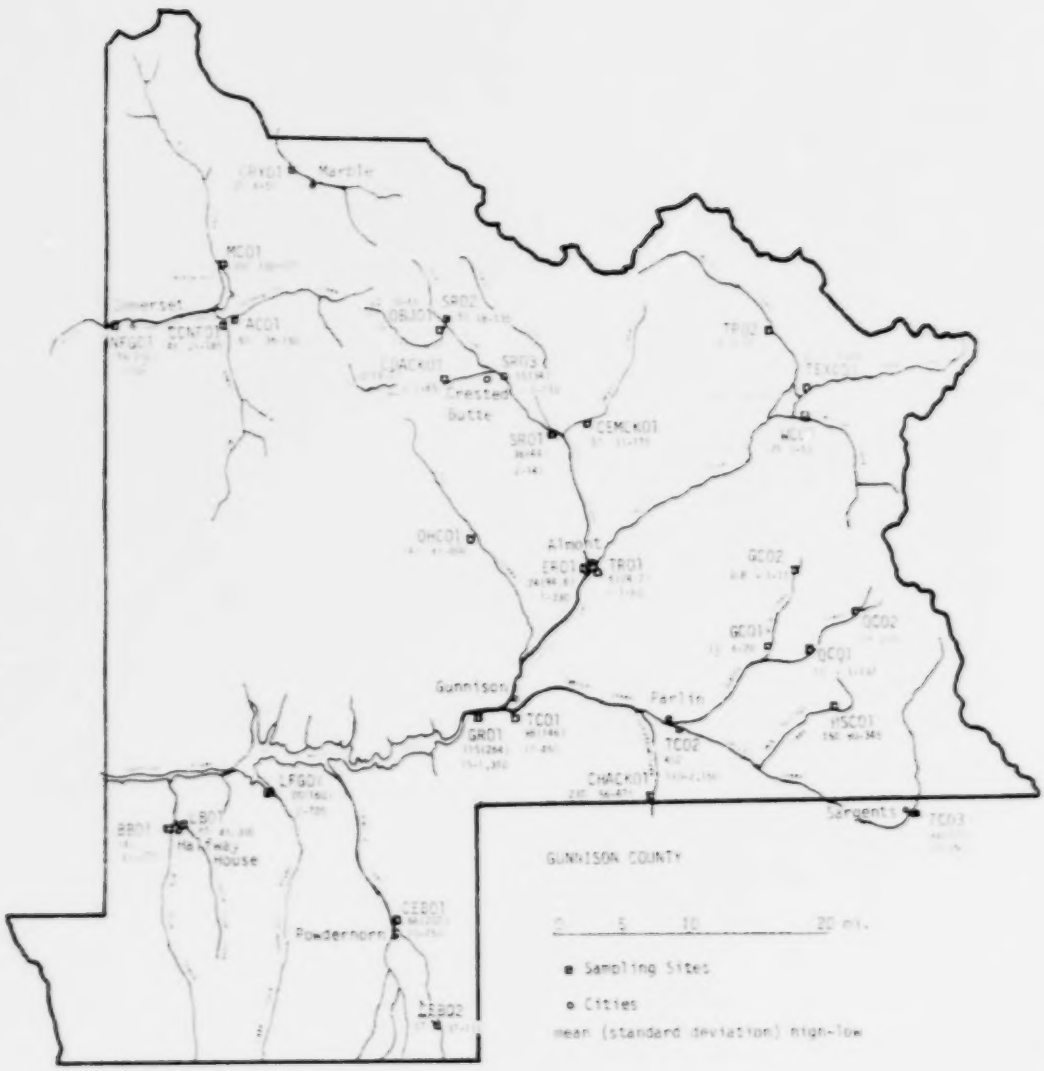


Figure A-5. Fecal Streptococcus

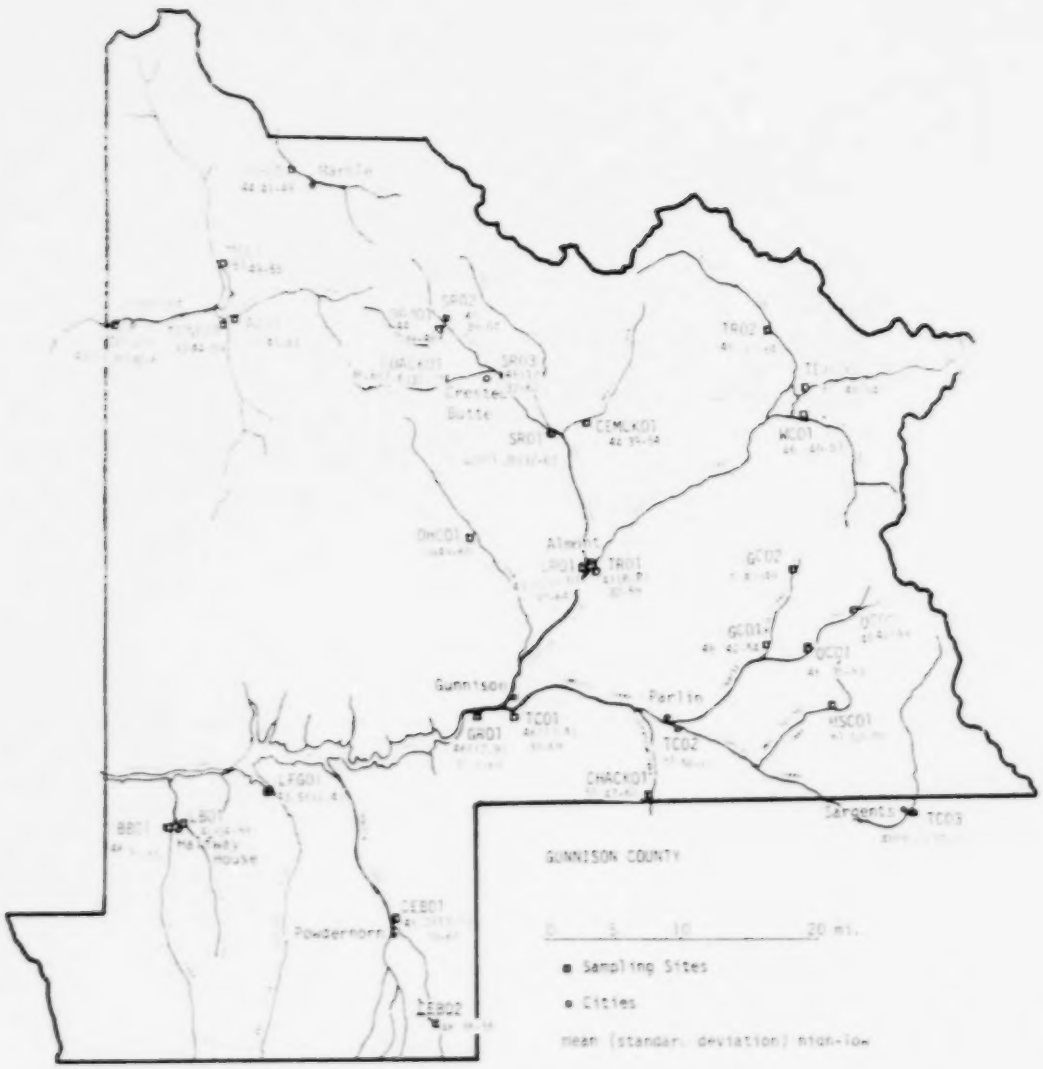


Figure A-6. Temperature (°F) of Surface Waters

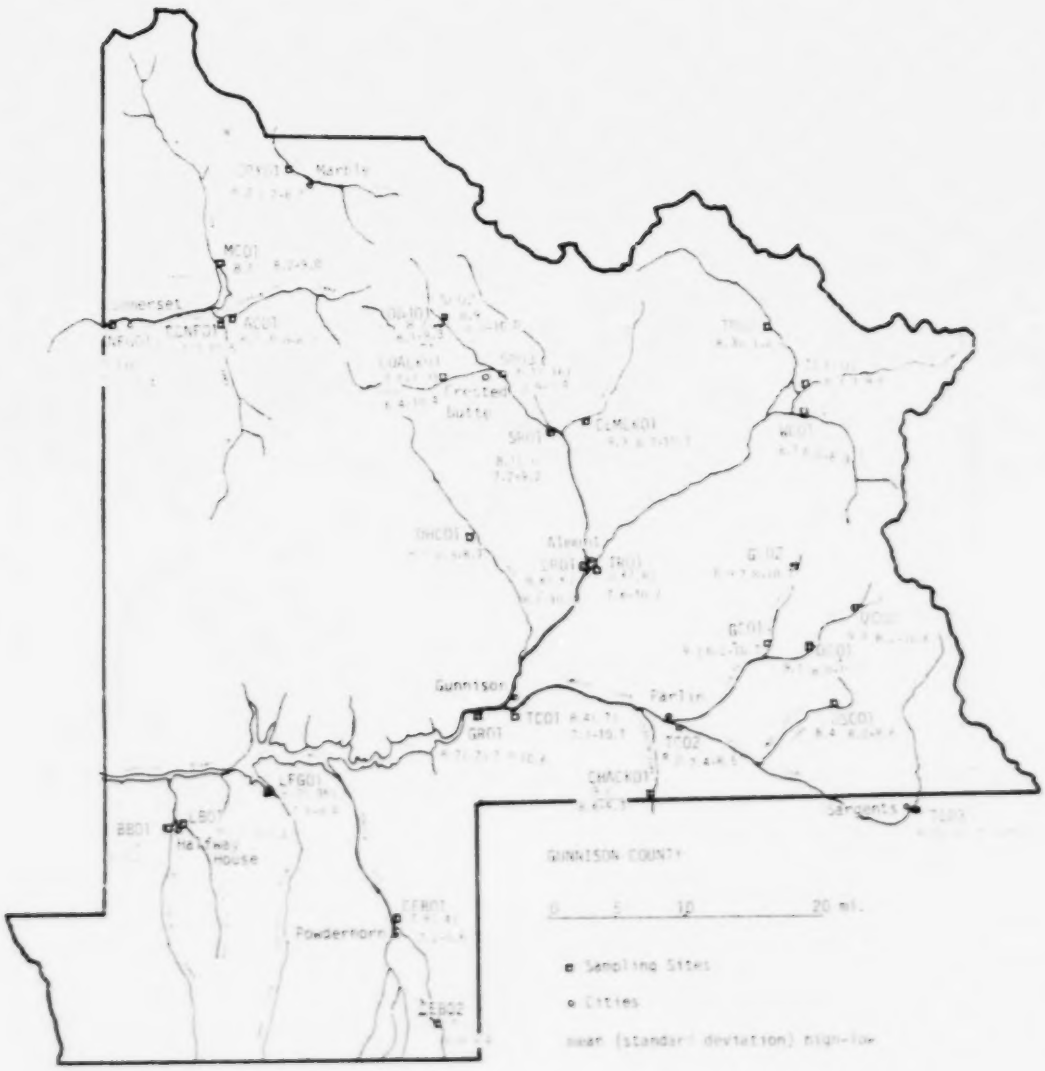


Figure A-7. pH (su) of surface waters

Figure A-6. Conductivity (µmho/cm) of Surface Waters

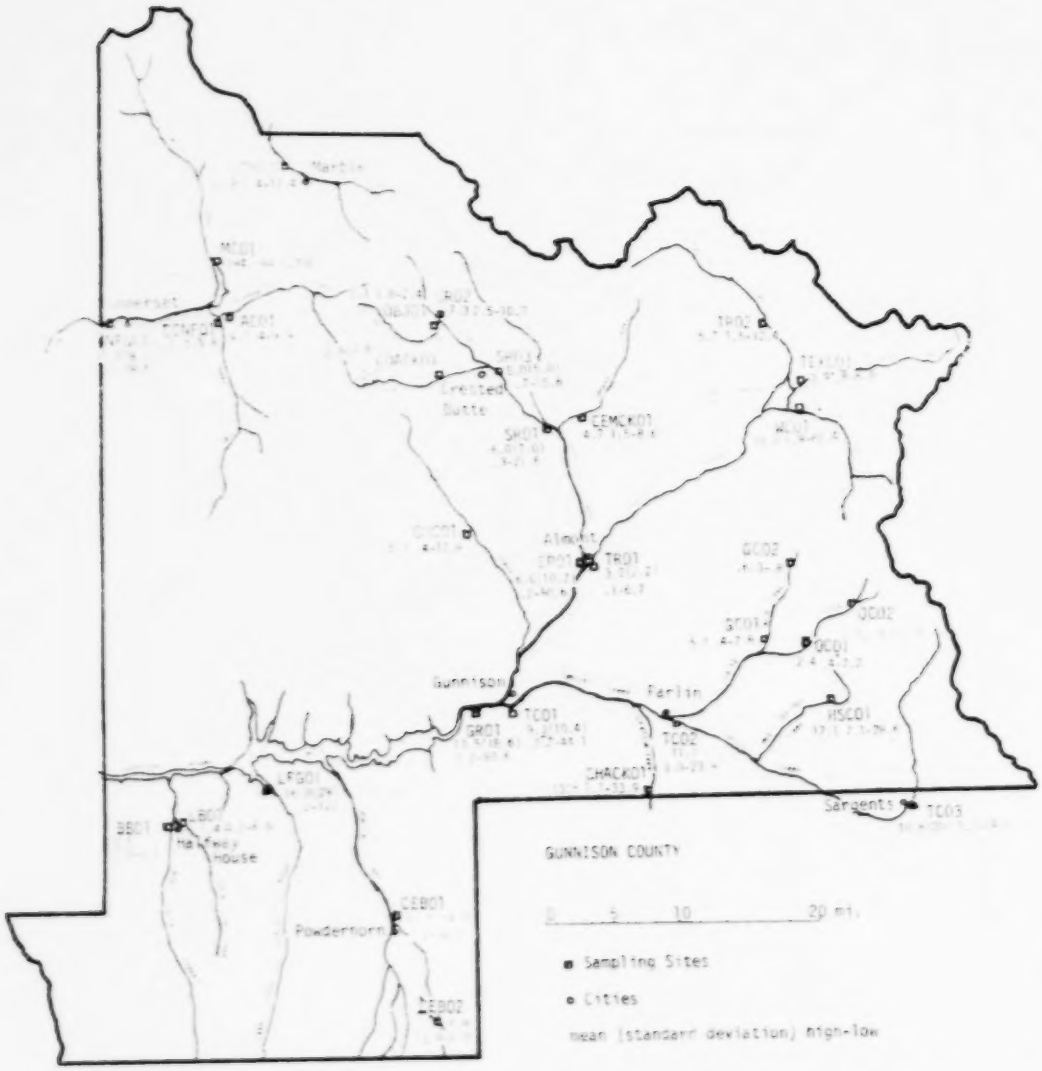


Figure A-5. Suspended Solids (mg/l) Content of Surface Waters

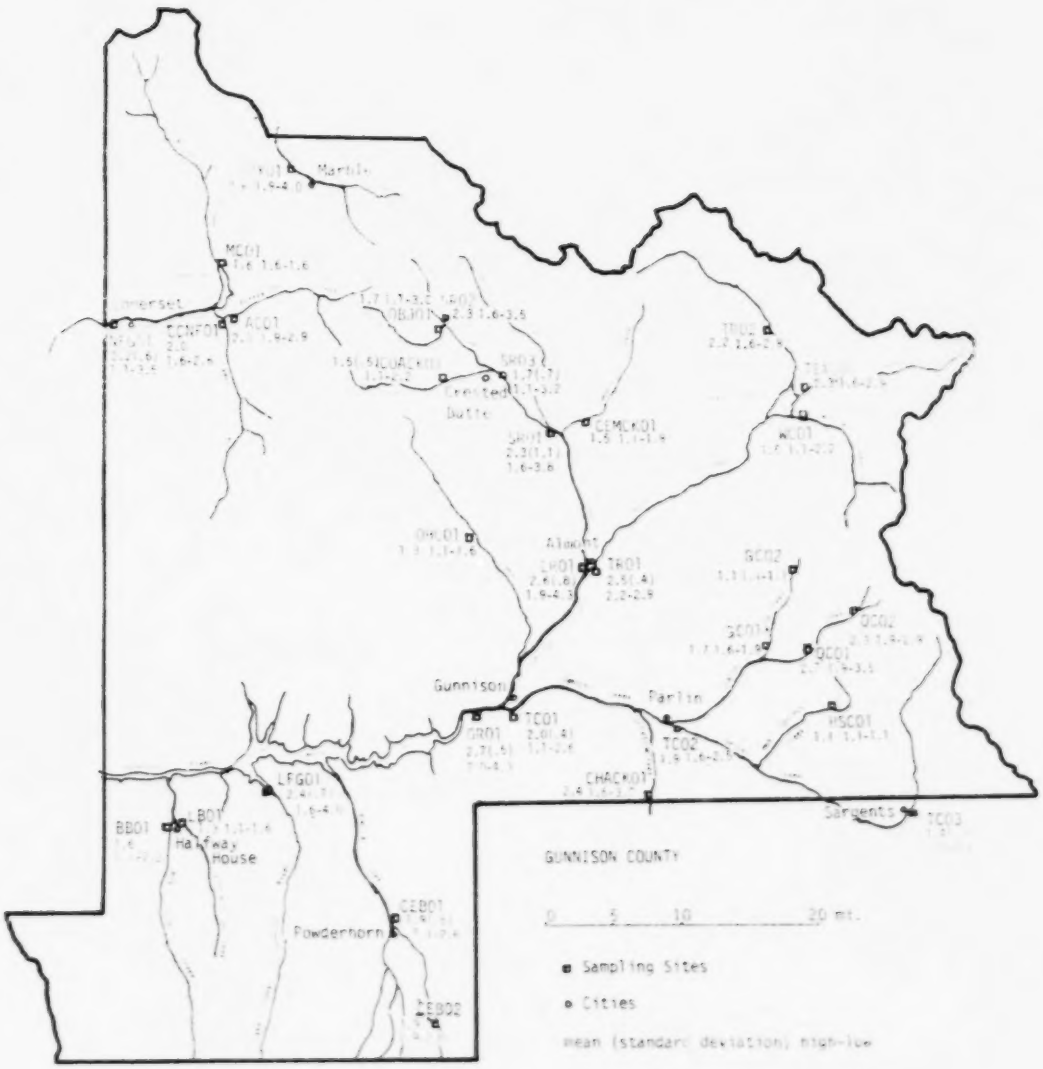


Figure 4-10. Velocity (ft/sec) of Surface Waters

Figure A-11. Total Ammonia Nitrogen (mg/l) Content of Surface Waters

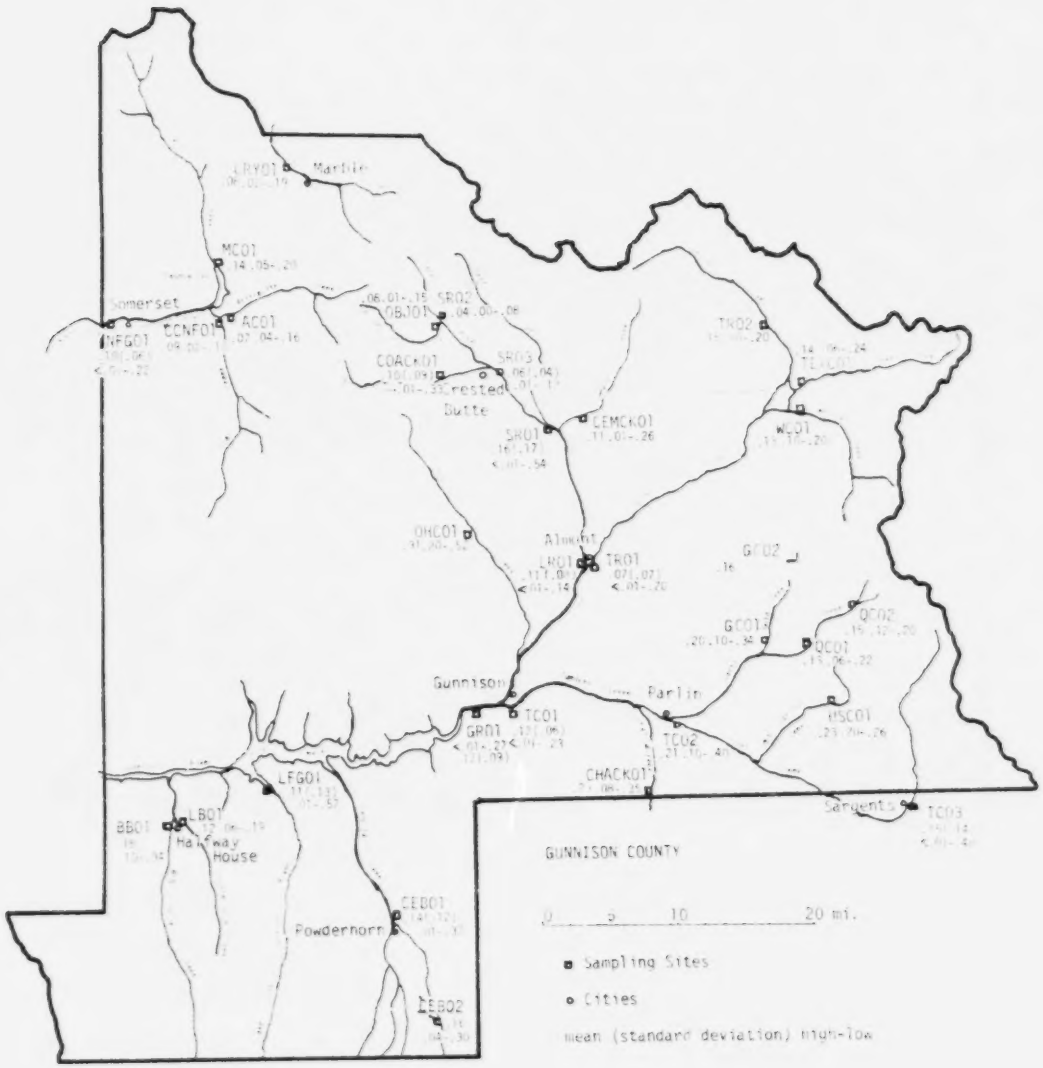


Figure A-12. Nitrate Nitrogen (mg/l) Content of Surface Waters

Figure 4-11. Phosphate Phosphorus (mg/l) Content of Surface Waters

GUNNISON COUNTY
Sampling Sites
Cities

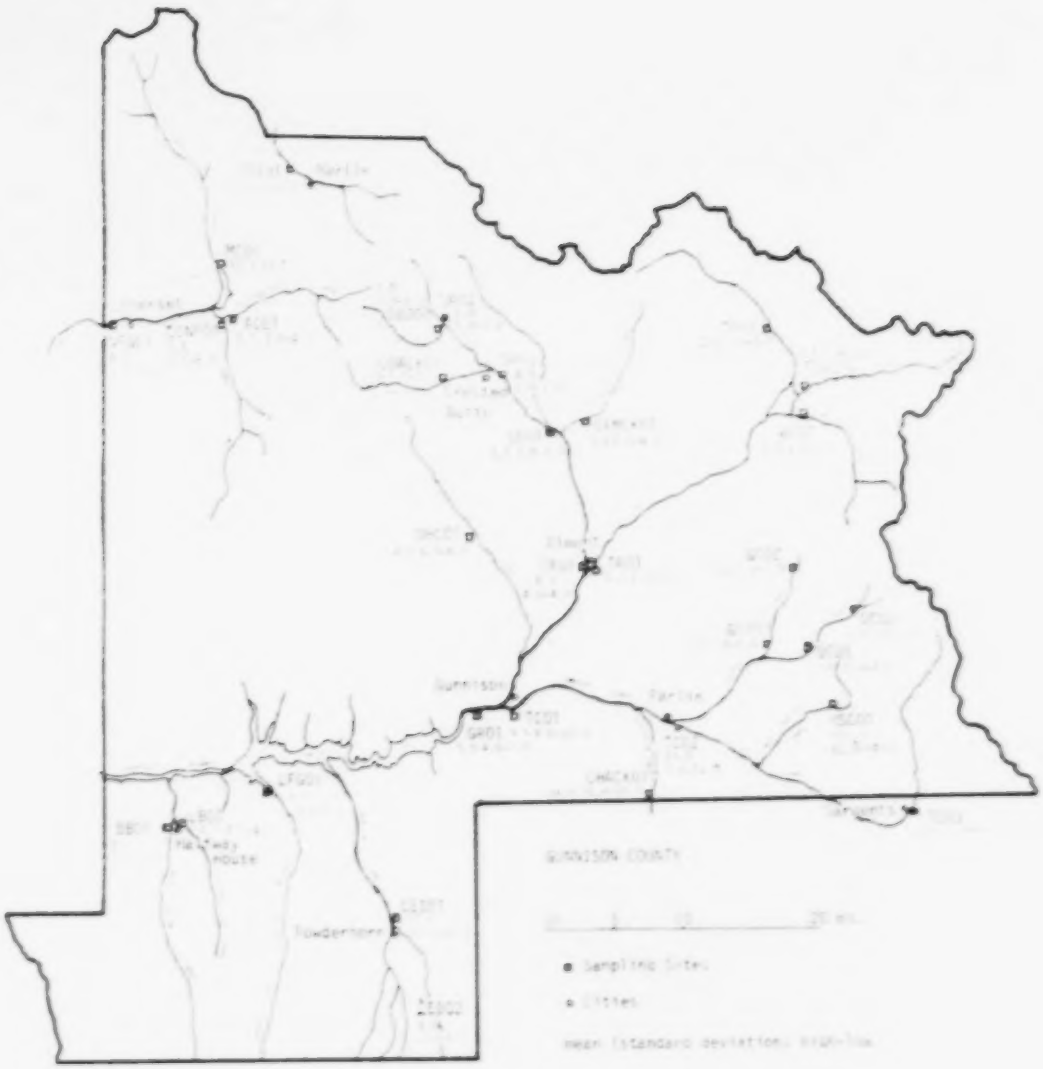

Figure 6-15. Sodium (mg/l) content of surface waters

SUNNISON COUNTY
Sampling Sites
Cities

Figure 6-17. Calcium (mg/l) content of surface waters

Figure 4-10. Magnesium (mg/l) Content of Surface Waters

Figure A-19. Sulfate (mg/l) Content of Surface Waters

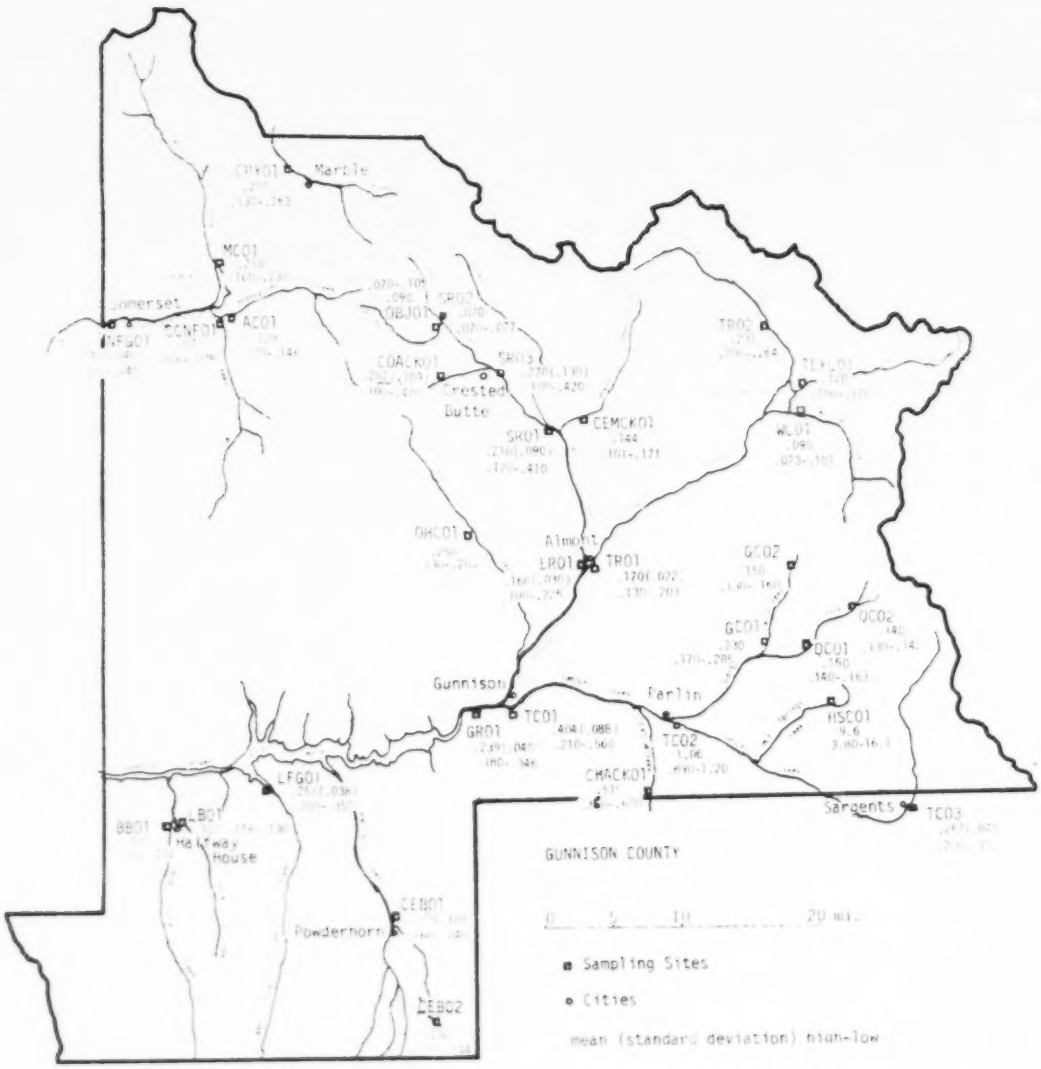


Figure A-20. Fluoride(mg/l) Content of Surface Waters

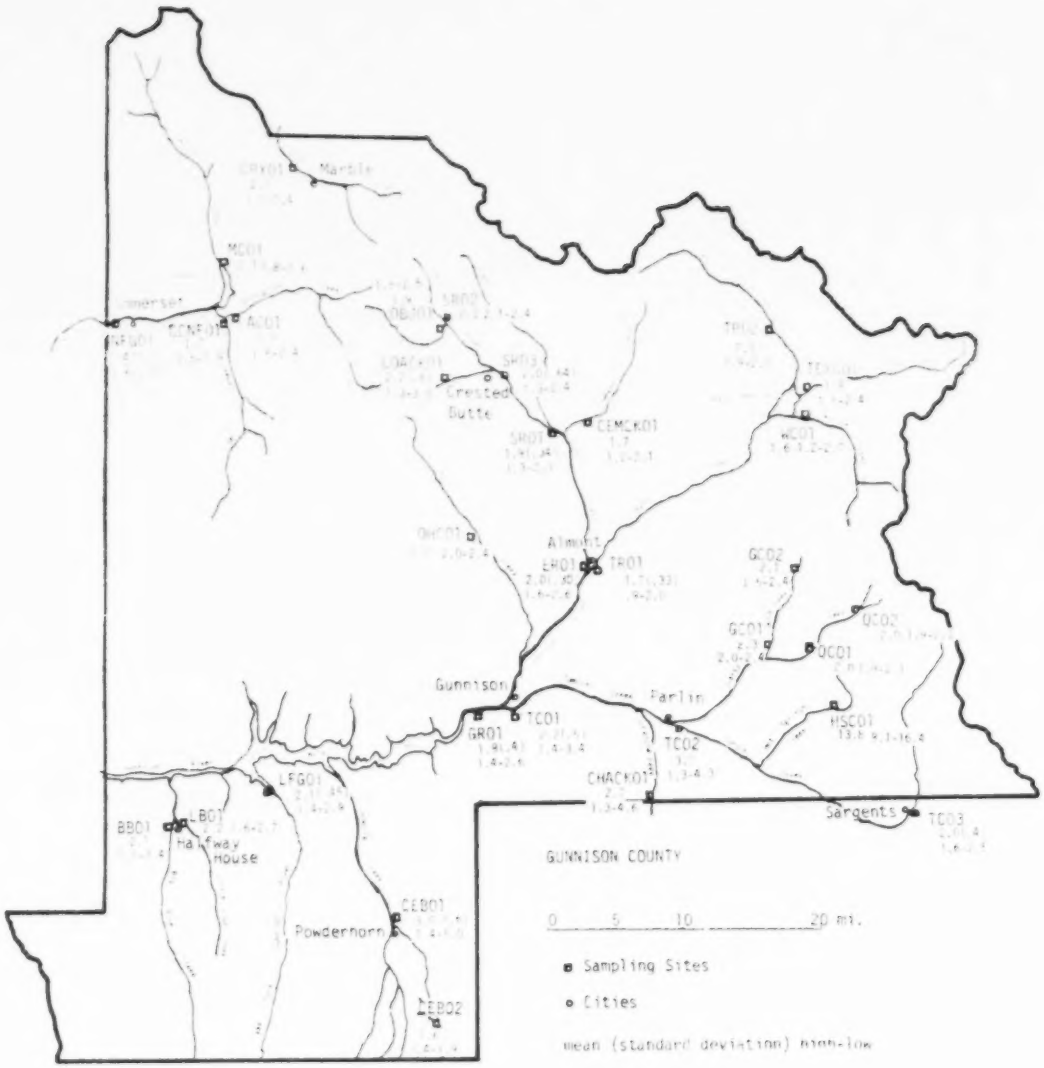


Figure A-21. Chloride (mg/l) Content of Surface Waters

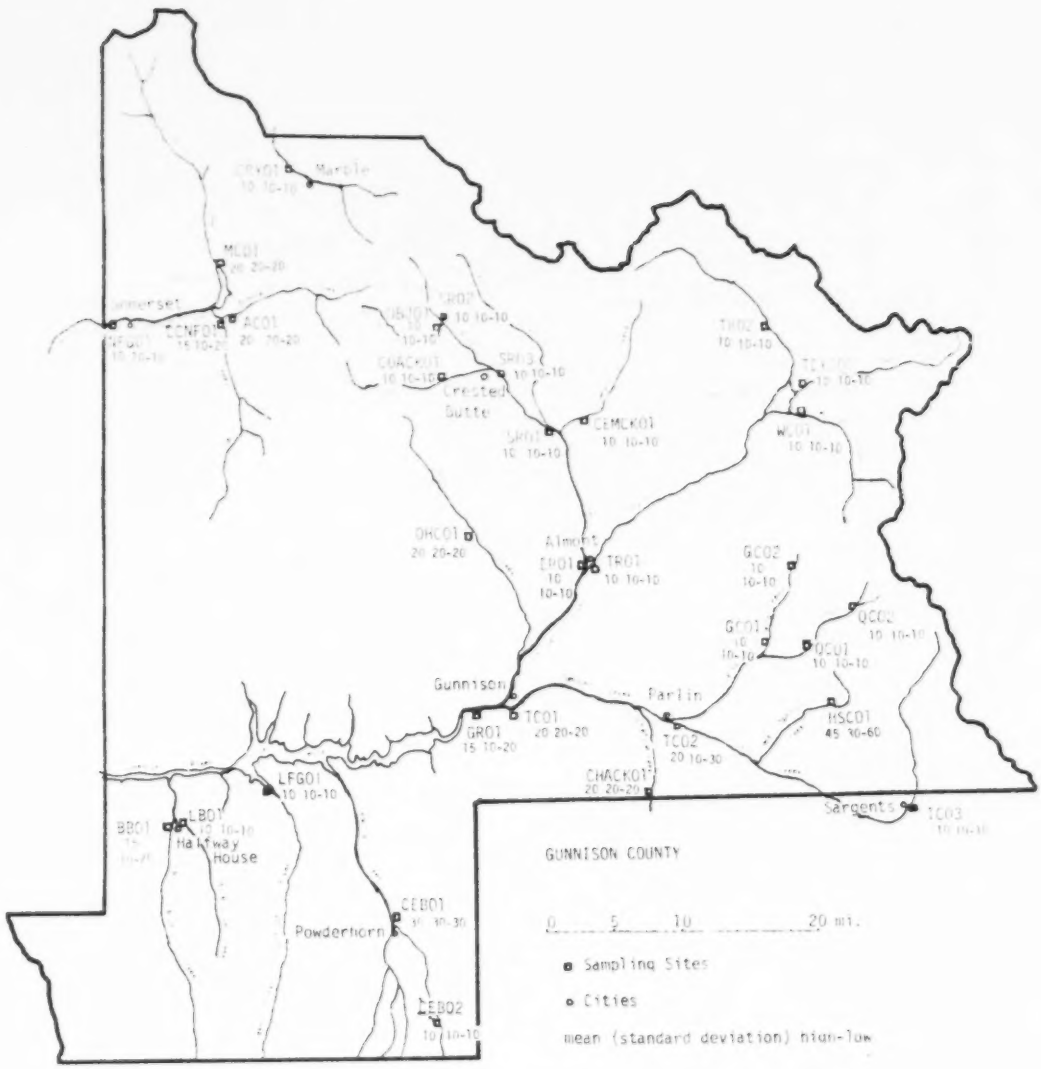


Figure A-22. Boron (µg/l) Content of Surface Waters

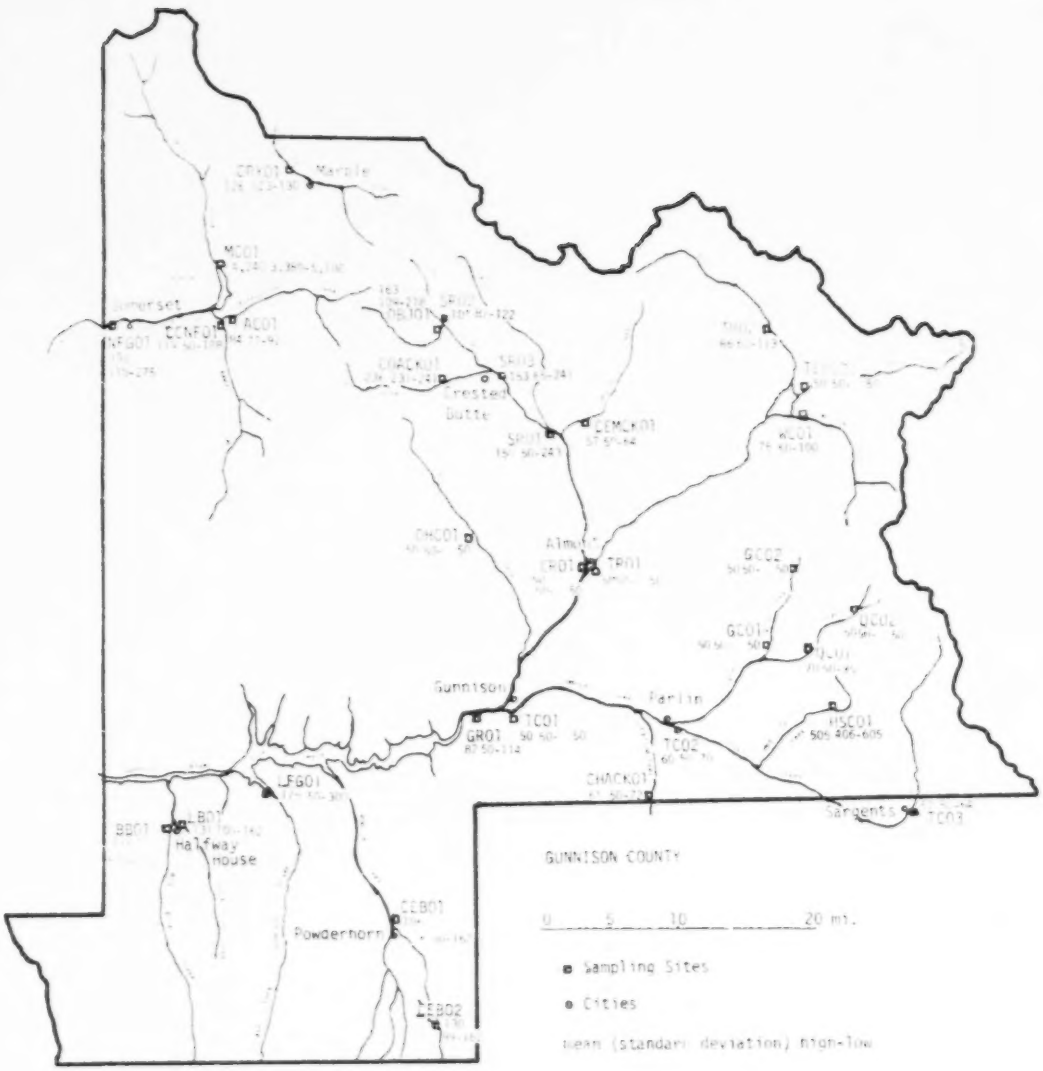


Figure A-23. Aluminum (ug/l) Content of Surface Waters

Figure A-24. Arsenic [µg/l] Content of Surface Waters

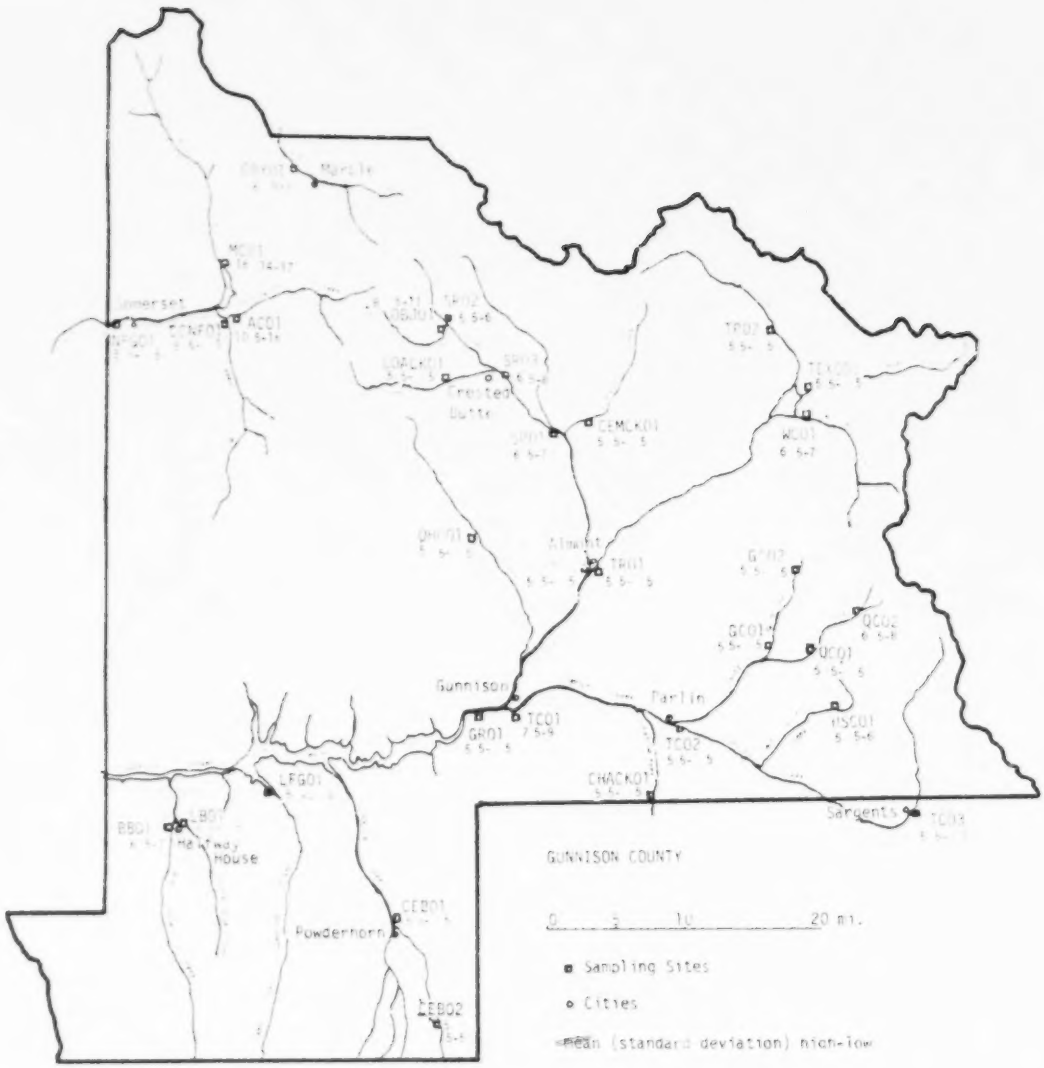


Figure 4-25. Copper (µg/l) Content of Surface Waters

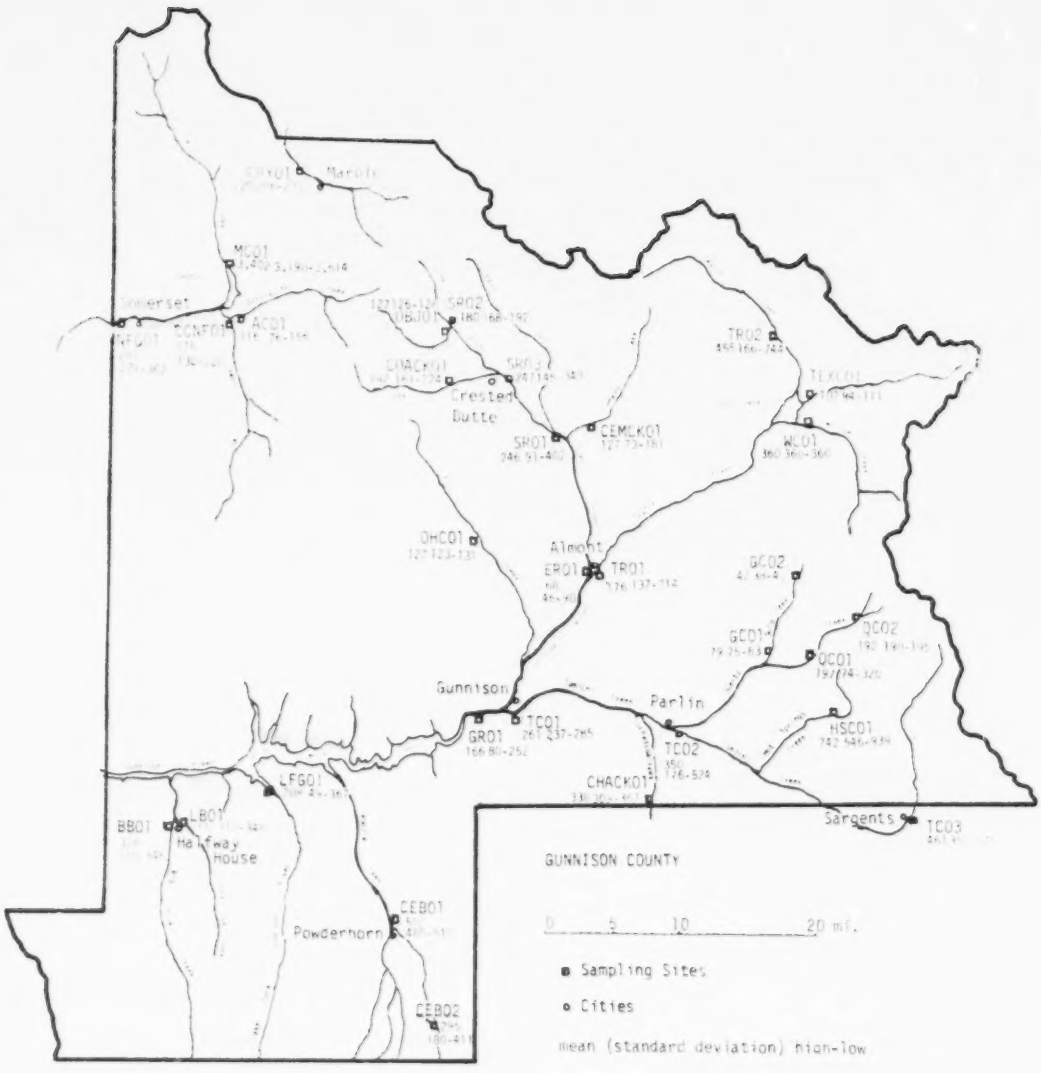


Figure 4-25. Iron (ug/l) Content of Surface Waters

Figure 4-27. Manganese (ug/l) Content of Surface Waters

Figure A-2d. Zinc (µg/l) Content of Surface Waters

Table A-8. MINERAL CONTENT - SEDIMENT

| SITE | Na mg/g | K mg/g | Ca mg/g | Mg mg/g | B [illegible]/g |
|---|---|---|---|---|---|
| ACO1 | 200 | 772 | 2,803 | 1,831 | 21 |
| BBO1 | 510 | 868 | 3,128 | 1,548 | 30 |
| CEBO1 | 197 | 880 | 2,202 | 1,160 | 22 |
| CEBO2 | 416 | 1,304 | 3,178 | 1,798 | 24 |
| CEMCKO1 | 72 | 384 | 7,496 | 2,268 | 11 |
| CHACKO1 | 80 | 1,306 | 3,218 | 2,877 | 21 |
| COACKO1 | 182 | 1,380 | 3,551 | 2,482 | 36 |
| CCNFO1 | 291 | 969 | 3,335 | 2,292 | 26 |
| CRYO1 | 78 | 620 | 6,878 | 2,117 | 21 |
| ERO1 | 242 | 438 | 2,296 | 1,136 | 10 |
| GCO1 | 69 | 390 | 1,227 | 1,267 | 15 |
| GCO1 | 112 | 816 | 2,918 | 4,898 | 33 |
| GRO1 | 614 | 629 | 4,118 | 1,464 | 18 |
| HSCK01 | 362 | 600 | 1,998 | 978 | 12 |
| LFGO1 | 543 | 1,006 | 2,992 | 6,086 | 19 |
| LBO1 | 184 | 685 | 1,487 | 941 | 14 |



(continued)

Table A-8. (continued)

| SITE | Na mg/g | K mg/g | Ca mg/g | Mg mg/g | B µg/g |
|---|---|---|---|---|---|
| MC01 | 284 | 554 | 2,427 | 1,787 | 15 |
| NFG01 | 325 | 785 | 5,647 | 2,243 | 22 |
| OBJ01 | 559 | 937 | 3,232 | 2,992 | 30 |
| OHC01 | 200 | 550 | 4,884 | 2,082 | 17 |
| QC01 | 69 | 640 | 5,339 | 1,490 | 14 |
| QC02 | 60 | 438 | 1,818 | 1,651 | 16 |
| SR01 | 316 | 410 | 2,472 | 1,483 | 16 |
| SR02 | 543 | 1,006 | 5,432 | 6,086 | 302 |
| SR03 | 355 | 561 | 2,884 | 2,013 | 20 |
| TR01 | 76 | 717 | 1,963 | 1,485 | 15 |
| TR02 | 116 | 879 | 2,261 | 1,581 | 23 |
| TEXC01 | 66 | 754 | 1,320 | 1,362 | 16 |
| TC01 | 163 | 931 | 5,777 | 1,839 | 15 |
| TC02 | 196 | 198 | 5,190 | 3,538 | 40 |
| TC03 | 106 | 759 | 1,947 | 988 | 15 |
| WC01 | 168 | 664 | 4,556 | 2,808 | 32 |

Table A-9. HEAVY METALS - SEDIMENT - Part I

| SITE | Al mg/g | As mg/g | Cd mg/g | Cr mg/g | Cu mg/g |
|---|---|---|---|---|---|
| ACO1 | 7,193 | 2.1 | 0.22 | 2.2 | 6.6 |
| BBO1 | 4,932 | 3.6 | 0.27 | 3.3 | 7.4 |
| CEBO1 | 2,846 | 16.5 | 0.26 | 0.53 | 4.5 |
| CEBO2 | 4,796 | 1.8 | 0.51 | 1.0 | 6.4 |
| CEMCKO1 | 2,717 | 2.3 | 0.36 | 3.6 | 2.5 |
| CHACKO1 | 6,130 | 2.1 | 0.38 | 4.6 | 28.0 |
| COACKO1 | 5,923 | 12.7 | 0.55 | 4.7 | 7.7 |
| CONFO1 | 3,335 | 2.4 | 0.62 | 2.5 | 7.8 |
| CRYO1 | 4,300 | 5.2 | 0.65 | 2.3 | 11.3 |
| ERO1 | 4,125 | 3.8 | 1.21 | 2.8 | 8.8 |
| GCO1 | 2,667 | 29.5 | 0.09 | 3.2 | 15.4 |
| GCO2 | 7,755 | 1.7 | 1.02 | 8.2 | 17.0 |
| GRO1 | 4,768 | 2.0 | 0.84 | 1.7 | 5.7 |
| HSCKO1 | 2,900 | 1.3 | 0.33 | 2.2 | 5.3 |
| LFGO1 | 4,329 | 5.4 | 2.60 | 1.4 | 40.1 |
| LBO1 | 3,829 | 2.7 | 0.21 | 1.3 | 3.8 |

(continued)

Table A-9. (continued)

| SITE | Al mg/g | As µg/g | Cd µg/g | Cr µg/g | Cu µg/g |
|---|---|---|---|---|---|
| MCO1 | 7,544 | - | 1.22 | 5.7 | 17.0 |
| NFGO1 | 5,537 | 1.9 | 0.28 | 3.4 | 7.4 |
| OBJO1 | 12,234 | 11.2 | 6.00 | 9.8 | 33.0 |
| OHCO1 | 4.102 | 0.9 | 0.22 | 0.2 | 11.0 |
| QCO1 | 5,641 | 1.6 | 0.16 | 3.3 | 7.1 |
| QCO2 | 3,278 | 1.7 | 0.48 | 2.4 | 11.0 |
| SRO1 | 6,572 | 9.8 | 5.40 | 5.5 | 24.0 |
| SRO2 | 19,382 | 15.4 | 1.85 | 21.0 | 38.0 |
| SRO3 | 8,529 | 12.3 | 1.65 | 6.6 | 20.2 |
| TRO1 | 3,216 | 2.3 | 0.19 | 3.5 | 4.9 |
| TRO2 | 4,614 | 5.1 | 0.88 | 4.2 | 7.2 |
| TEXCO1 | 3,136 | 0.5 | 0.17 | 3.2 | 4.2 |
| TCO1 | 3,683 | 1.9 | 0.45 | 3.3 | 8.9 |
| TCO2 | 9,447 | 7.5 | 1.50 | 11.0 | 33.0 |
| TCO3 | 3,258 | 2.7 | 0.43 | 3.2 | 9.1 |
| WCO1 | 7,480 | 2.4 | 0.80 | 10.0 | 60.0 |

Table A-10. HEAVY METALS - SEDIMENT - Part II

| SITE | Fe mg/g | Mn mg/g | Pb mg/g | Zn mg/g |
|---|---|---|---|---|
| AC01 | 7,610 | 213 | 12.3 | 31.0 |
| BB01 | 10,310 | 510 | 10.7 | 30.0 |
| CEB01 | 7,846 | 383 | 6.6 | 18.6 |
| CEB02 | 8,699 | 301 | 10.2 | 28.0 |
| CEMCK01 | 4,638 | 145 | 6.2 | 15.0 |
| CHACK01 | 8,506 | 199 | 28.0 | 69.0 |
| COACK01 | 8,733 | 250 | 12.0 | 28.0 |
| CCNF01 | 10,404 | 239 | 19.2 | 46.0 |
| CRY01 | 7,300 | 206 | 14.0 | 37.0 |
| ER01 | 3,698 | 411 | 12.5 | 185.0 |
| GC01 | 5,218 | 219 | 105.0 | 95.0 |
| GC02 | 13,265 | 602 | 21.0 | 57.0 |
| GR01 | 7,110 | 173 | 15.0 | 107.0 |
| HSCK01 | 4,233 | 210 | 14.0 | 33.0 |
| LFG01 | 6,854 | 535 | 238.0 | 287.0 |
| LB01 | 5,232 | 219 | 8.1 | 19.0 |

(continued)

Table A-10. (continued)

| SITE | Fe µg/g | Mn µg/g | Pb µg/g | Zn µg/g |
|---|---|---|---|---|
| MCO1 | 5,853 | 303 | 40.0 | 235.0 |
| NFGO1 | 8,051 | 206 | 14.0 | 31.0 |
| OBJO1 | 10,381 | 796 | 278.0 | 681.0 |
| OHCO1 | 6,408 | 93 | 6.4 | 20.0 |
| QCO1 | 5,214 | 188 | 7.4 | 20.0 |
| QCO2 | 5,766 | 182 | 10.0 | 38.0 |
| SRO1 | 5,515 | 1,125 | 30.0 | 883.0 |
| SRO2 | 12,778 | 198 | 99.0 | 246.0 |
| SRO3 | 7,334 | 402 | 39.0 | 246.0 |
| TRO1 | 5,497 | 172 | 16.0 | 27.0 |
| TRO2 | 7,561 | 612 | 24.6 | 101.8 |
| TEXCO1 | 5,542 | 246 | 11.0 | 22.0 |
| TCO1 | 5,334 | 232 | 14.0 | 31.0 |
| TCO2 | 13.920 | 668 | 49.0 | 132.0 |
| TCO3 | 4,849 | 390 | 18.0 | 67.0 |
| WCO1 | 11,520 | 620 | 24.0 | 120.0 |

Table A-11. AVERAGE PARAMETER VALUES

Gunnison County STORET Data

| Parameter | STORET Parameter # | # of Measurements | Range | Average |
|---|---|---|---|---|
| Turbidity (Transmittance) | 00074 | 77 | 92-98% | 96% |
| Turbidity (FTU) | 00076 | 223 | < 1-432 FTU | 8.3 FTU |
| Conductivity | 00094 | 404 | 50.0-1200.0 µmho | 208.0 µmho |
| Dissolved Oxygen (DO) | 00300 | 212 | 513-10.4 mg/l | 8.1 mg/l |
| Biochemical Oxygen Demand ($BOD_5$) | 00310 | 112 | 1.17-1.63 mg/l | 1.4 mg/l |
| COD (Low Level) | 00335 | 4 | 30.0 mg/l | 30.0 mg/l |
| pH | 00400 | 377 | 3.0-8.8 su | 7.9 su |
| $CO_2$ | 00405 | 29 | 0.8-19.0 mg/l | 7.3 mg/l |
| Total Alkalinity ($CaCO_3$) | 00410 | 114 | 0.108.0 mg/l | 74.4 mg/l |
| Phenolphthelien Alkalinity | 00415 | 18 | 0-20.0 mg/l | 4.4 mg/l |
| Bicarbonate Alkalinity ($CaCO_3$) | 00425 | 39 | 26.0-202.0 mg/l | 110.5 mg/l |
| $HCO_3$ Ion | 00440 | 44 | 12.0-132.0 mg/l | 77.5 mg/l |
| $CO_3$ Ion | 00445 | 10 | 0-4.5 mg/l | 0.4 mg/l |
| Residue, total | 00500 | 53 | 1.0-200.0 mg/l | 133.0 mg/l |
| Residue, Volatile, total | 00505 | 61 | 3.0-47.3 mg/l | 20.8 mg/l |
| Suspended Solids-Non Filterable | 00530 | 126 | 3.0-24.0 mg/l | 14.0 mg/l |
| Residue, Settleable | 00545 | 50 | 0.1 mg/l | 0.1 mg/l |
| Organic N, diss | 00607 | 2 | 0.060 mg/l | 0 .060 mg/l |
| $NH_3$-N, diss | 00608 | 27 | 0.02-0.64 mg/l | 0.19 mg/l |
| $NH_3$-N, total | 00610 | 254 | 0.02-2.90 mg/l | 0.09 mg/l |
| $NO_2$-N, diss | 00613 | 2 | 0-0.010 mg/l | 0.005 mg/l |
| $NO_2$-N, total | 00615 | 163 | 0.001-0.040 mg/l | 0.002 mg/l |



(continued)

Table A-11. (continued)

| Parameter | STORET Parameter # | # of Measurements | Range | Average |
|---|---|---|---|---|
| $NO_3$-N, diss | 00618 | 13 | 0.08-1.0 mg/l | 0.49 mg/l |
| $NO_3$-N, total | 00620 | 364 | < 0.10-0.24 mg/l | 0.07 mg/l |
| Kjeldahl N, diss | 00623 | 2 | 0.14 mg/l | 0.14 mg/l |
| Total Kjeldahl N | 00625 | 86 | 0.020-11.16 mg/l | 1.19 mg/l |
| $NO_2$+$NO_3$-N, total | 00630 | 85 | 0.02-24.7 mg/l | 1.27 mg/l |
| $NO_2$+$NO_3$-N, diss | 00631 | 13 | 0.01-0.19 mg/l | 0.08 mg/l |
| $PO_4$, total | 00650 | 124 | 0.077-0.183 mg/l | 0.123 mg/l |
| $PO_4$, Ortho | 00660 | 15 | 0.030-1.00 mg/l | 0.136 mg/l |
| Phosphorus, total | 00665 | 163 | 0.017-6.87 mg/l | 0.344 mg/l |
| Phosphorus, diss | 00666 | 6 | 0.010-0.015 mg/l | 0.013 mg/l |
| Phosphorus Ortho, diss | 00671 | 96 | 0.006-4.71 mg/l | 0.333 mg/l |
| Phosphorus Hydro, diss | 00672 | 2 | 0-0.015 mg/l | 0.008 mg/l |
| Phosphorus Organic, diss | 00673 | 2 | 0.00 mg/l | 0.00 mg/l |
| Organic Carbon, C, diss | 00681 | 2 | 5.10 mg/l | 2.55 mg/l |
| Cyanide, $CN^-$, total | 00720 | 68 | 0.00 mg/l | 0.00 mg/l |
| Total Hardness, $CaCO_3$ | 00900 | 293 | 15.0-470.0 mg/l | 117.0 mg/l |
| Carbonate Hardness, $CaCO_3$ | 00901 | 39 | 36.0-162.0 mg/l | 93.0 mg/l |
| Non Carbonate Hardness, $CaCO_3$ | 00902 | 29 | 0.00-390.0 mg/l | 41.3 mg/l |
| Calcium, $CaCO_3$ | 00910 | 178 | 54.4-120.1 mg/l | 89.2 mg/l |
| Calcium, Ca, diss | 00915 | 29 | 5.0-170.0 mg/l | 29.7 mg/l |
| Magnesium, $CaCO_3$ | 00920 | 178 | 6.4-10.1 mg/l | 8.4 mg/l |
| Magnesium, Mg, diss | 00925 | 32 | 0.00-12.0 mg/l | 4.3 mg/l |
| Sodium, Na, total | 00929 | 185 | 2.58-8.89 mg/l | 5.25 mg/l |



(continued)

Table A-11. (continued)

| Parameter | STORET Parameter # | # of Measurements | Range | Average |
|---|---|---|---|---|
| Sodium, Na, diss | 00930 | 28 | 1.0-160.0 mg/l | 8.48 mg/l |
| Sodium, Na, Adsorption Ratio | 00931 | 194 | 0.00-18.00 | 0.30 |
| Sodium, Na, % | 00932 | 11 | 1.0-93.0% | 16.8% |
| Potassium, K, diss | 00935 | 13 | 0.00-10.00 mg/l | 1.65 mg/l |
| Chloride, $Cl^-$ | 00940 | 229 | 0.20-10.0 mg/l | 4.7 mg/l |
| Sulfate, $SO_4$, total | 00945 | 178 | 3.4-390.0 mg/l | 26.5 mg/l |
| Sulfate, $SO_4$, diss | 00946 | 35 | 5.0-30.0 mg/l | 13.8 mg/l |
| Fluoride, $F^-$, diss | 00950 | 13 | 0.10-18.00 mg/l | 1.55 mg/l |
| Fluoride, $F^-$, total | 00951 | 129 | 0.234-0.442 mg/l | 0.300 mg/l |
| Silica, diss | 00955 | 13 | 3.8-130.0 mg/l | 17.1 mg/l |
| Arsenic, As, diss | 01000 | 17 | 0.00-6.0 µg/l | 0.94 µg/l |
| Arsenic, As, total | 01002 | 119 | 0.00 | 0.00 |
| Boron, B, diss | 01020 | 1 | 70.0 µg/l | 70.0 µg/l |
| Boron, B, total | 01022 | 167 | 7.1-19.5 µg/l | 11.6 µg/l |
| Cadmium, Cd, diss | 01025 | 36 | 0.00-57.3 µg/l | 7.0 µg/l |
| Cadmium, Cd, total | 01027 | 114 | 0.00-0.18 µg/l | 0.001 µg/l |
| Chromium, Hex-Val | 01032 | 126 | 0.00 | 0.00 |
| Cobalt, Co, diss | 01035 | 10 | 0.00-10.0 µg/l | 1.4 µg/l |
| Copper, Cu, diss | 01040 | 33 | < .1-120.0 µg/l | 15.2 µg/l |
| Copper, Cu, total | 01042 | 138 | 0.00-275.0 µg/l | 8.5 µg/l |
| Iron, Fe, total | 01045 | 195 | 60.3-32,000.0 µg/l | 433.9 µg/l |
| Iron, Fe, diss | 01046 | 36 | 10.0-1400.0 µg/l | 138.6 µg/l |



(continued)

Table A-11. (continued)

| Parameter | STORET Parameter # | # of Measurements | Range | Average |
|---|---|---|---|---|
| Lead, Pb, diss | 01049 | 34 | 1.0-1130.0 µg/l | 58.8 µg/l |
| Lead, Pb, total | 01051 | 126 | 0.00-11.3 µg/l | 4.0 µg/l |
| Manganese, Mn, total | 01055 | 189 | 13.0-100,000.0 µg/l | 805.6 µg/l |
| Molybdenum, Mo, diss | 01060 | 9 | 0.00-< 333.0 µg/l | < 333.0 µg/l |
| Molybdenum, Mo, total | 01062 | 58 | 0.00-4.3 µg/l | 1.6 µg/l |
| Nickel, Ni, diss | 01065 | 27 | 0.00-24.3 µg/l | 4.5 µg/l |
| Nickel, Ni, total | 01067 | 12 | 25.0-37.5 µg/l | 31.2 µg/l |
| Silver, Ag, diss | 01075 | 11 | 0.00 | 0.00 |
| Silver, Ag, total | 01077 | 62 | 0.00-0.9 µg/l | 0.2 µg/l |
| Zinc, Zn, diss | 01090 | 34 | 0.00-100,000.0 µg/l | 4,543.0 µg/l |
| Zinc, Zn, total | 01092 | 181 | 5.6-8050.0 µg/l | 207.0 µg/l |
| Lithium, Li, diss | 01130 | 1 | 210.0 µg/l | 210.0 µg/l |
| Selenium, Se, diss | 01145 | 8 | 0.00-6.0 µg/l | 0.75 µg/l |
| Selenium, Se, total | 01147 | 122 | 0.2-0.6 µg/l | 0.3 µg/l |
| Detergent Suds, Severity | 01305 | 3 | 0.00 | 0.00 |
| Turbidity, Severity | 01350 | 13 | 0.00-2.0 | 0.31 |
| Total Coliform - MPN, Conf. | 31505 | 219 | 187-7,489 col/100ml | 3,267 col/100ml |
| Fecal Coliform - MPN, EC, Med | 31615 | 248 | 0-1,087 col/100ml | 356 col/100ml |
| Fecal Streptococci - MPN, K.F.Br) | 31675 | 18 | 13-595 col/100ml | 221 col/100ml |
| Chlorophyll, A | 32217 | 12 | 4.6-11.6 µg/l | 6.8 µg/l |
| MBAS | 38260 | 126 | 0.00 | 0.00 |
| Algae, total | 60050 | 3 | 760-2,300 cells/ml | 1,520 cells/ml |

(continued)

Table A-11. (continued)

| Parameter | STORET Parameter # | # of Measurements | Range | Average |
|---|---|---|---|---|
| Ammonia, $NH_4$, diss | 71846 | 2 | 0.11 mg/l | 0.06 mg/l |
| Nitrate, $NO_3^-$, total | 71850 | 8 | < 1 mg/l | < 1 mg/l |
| Nitrate, $NO_3^-$, diss | 71851 | 2 | 0.38 mg/l | 0.19 mg/l |
| Nitrite, $NO_2^-$, diss | 71856 | 2 | 0.03 mg/l | 0.02 mg/l |
| Mercury, Hg, diss | 71890 | 12 | 0.00-1.0 µg/l | 0.2 µg/l |
| Mercury, Hg, total | 71900 | 34 | 0.00-0.2 µg/l | 0.1 µg/l |

# REFERENCES


1. U.S. Environmental Protection Agency, Methods for Chemical Analyses of Water and Wastes, Methods Development and Quality Assurance Research Laboratory, National Environmental Research Center, Cincinnati, Ohio., 1974. EPA-625-/6-74-003. 298 pp.

2. American Public Health Association, American Water Works Association and Water Pollution Control Federation, Standard Methods for the Examination of Water and Wastewater, 14th Edition, 1975. 1193 pp.

3. Four Corners Environmental Research Institute, Biological and Chemical Studies of Selected Reaches and Tributaries of the Colorado River in the State of Colorado, Prepared for the Colorado Department of Public Health, Denver, Colorado, 1976. 95 pp.

4. Water Quality Control Division, Colorado Department of Public Health, The Upper Gunnison River Drainage, October, 1975. 70 pp.

5. U.S. Department of the Interior, Bureau of Reclamation, Water Measurement Manual, 2nd Edition. Cat. No. I 27.19/2: W29/2/974.

6. Water Quality Control Commission, Colorado Department of Public Health, Water Quality Standards and Stream Classification, Adopted: January 15, 1974; Effective: June 19, 1974. 52 pp.

7. Water Quality Control Commission, Colorado Department of Public Health, Water Quality Standards for Colorado, Adopted: May 2, 1978; Effective: July 20, 1978.